Plastics

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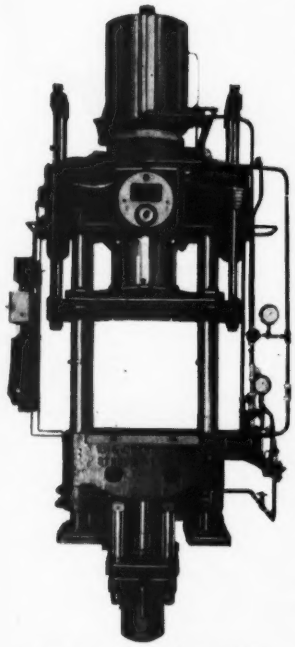

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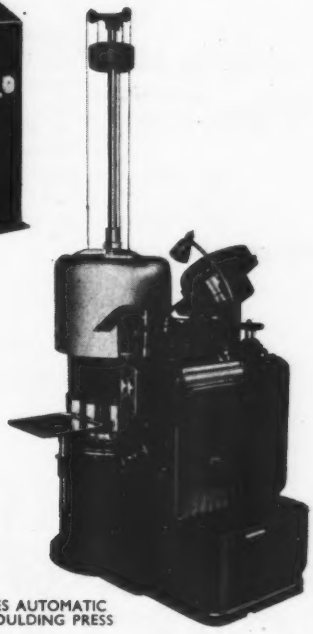

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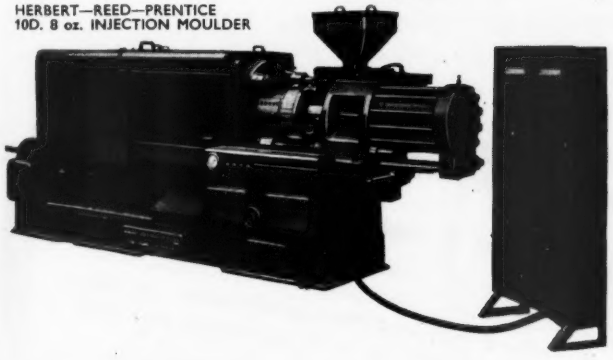

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Unsaponifiable	Trace
Iodine Value	0·8
Titre	13° C.

AVERAGE COMPOSITION

Caprylic	90%
Caproic	3%
Capric	7%

CAPRYLIC CAPRIC ACID
A101/2
AVERAGE TESTS

Acid Value	330/340
Saponification Value	330/340
Mean Molecular weight of Fatty Acid ..	160/165
Unsaponifiable ..	1% max.
Iodine Value ..	1 max.
Flow Point	0/10° C.

AVERAGE COMPOSITION

Caproic	Trace
Caprylic	35-45%
Capric	30-35%
Lauric	20-25%

CAPRIC ACID
A102
AVERAGE TESTS

Acid Value	323·7
Saponification Value ..	323·7
Mean Molecular weight of Fatty Acid	173·3
Unsaponifiable	0·5%
Iodine Value	1·2
Titre	30° C.

AVERAGE COMPOSITION

Capric	90%
Lauric	7%
Caprylic	3%

LAURIC ACID
A103
AVERAGE TESTS

Acid Value	276 min.
Saponification Value	276
Mean Molecular weight of Fatty Acid ..	203
Unsaponifiable ..	0·5% max.
Iodine Value ..	1 max.
Titre	37·8° C.

AVERAGE COMPOSITION

Capric	Trace
Lauric	90%
Myristic	9%
Unsaturated Acids ..	1%

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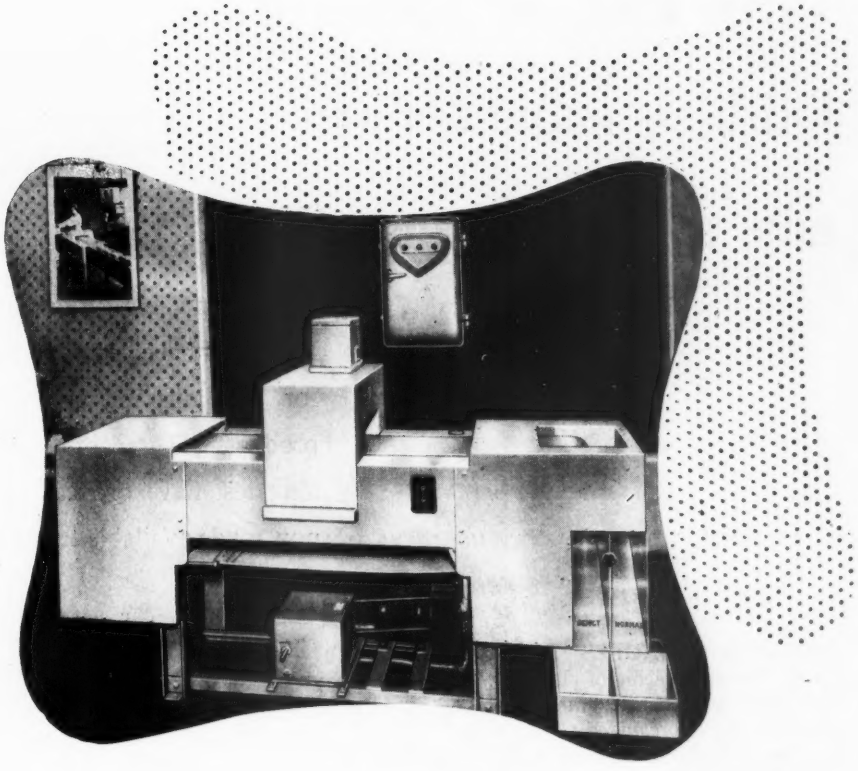

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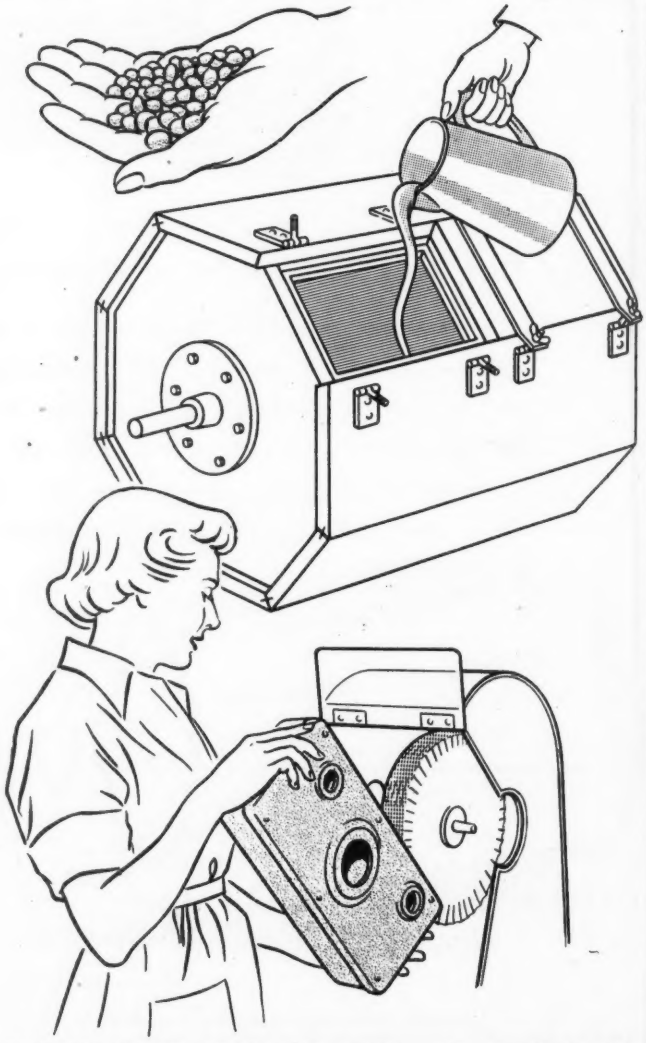

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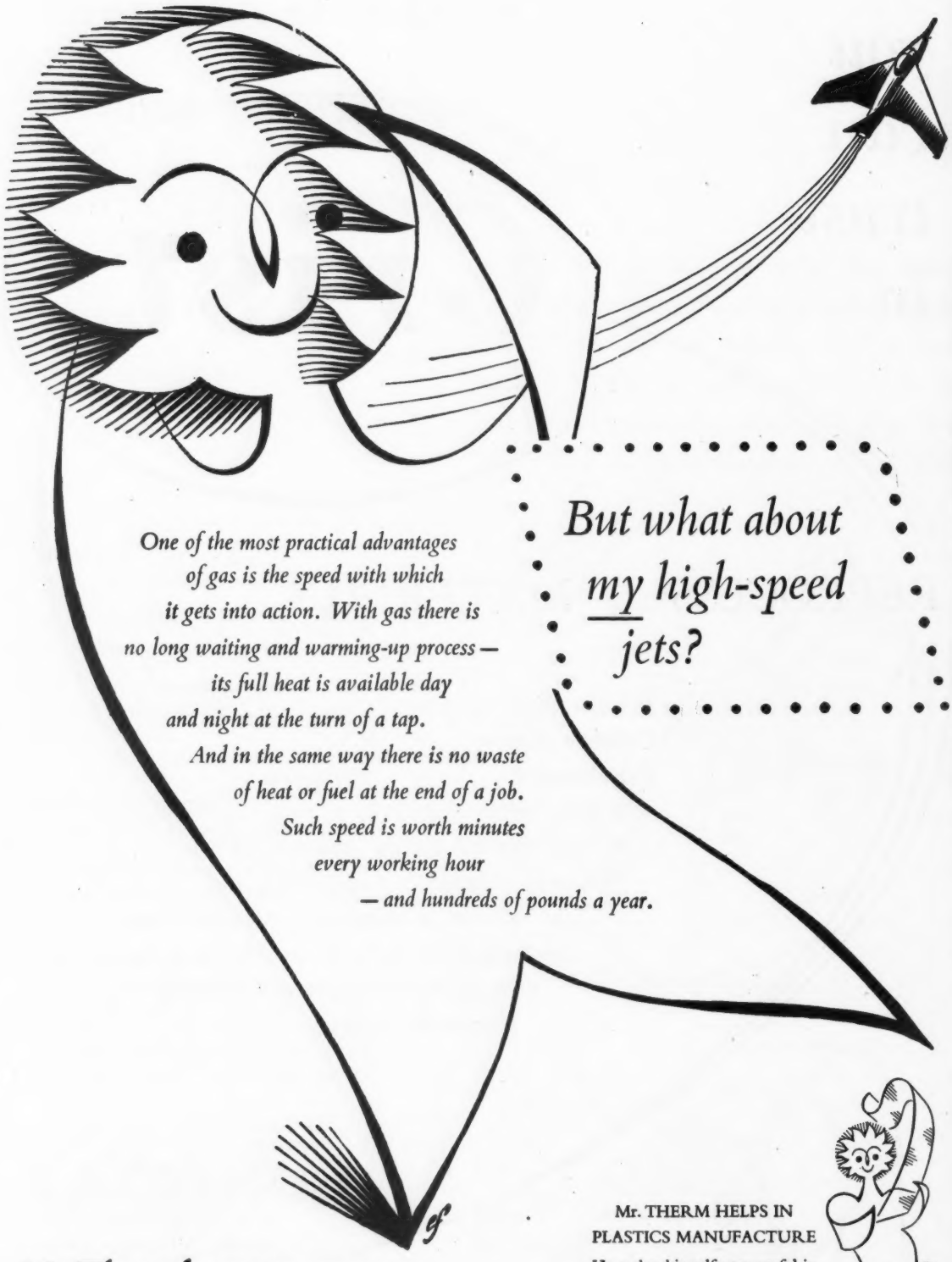

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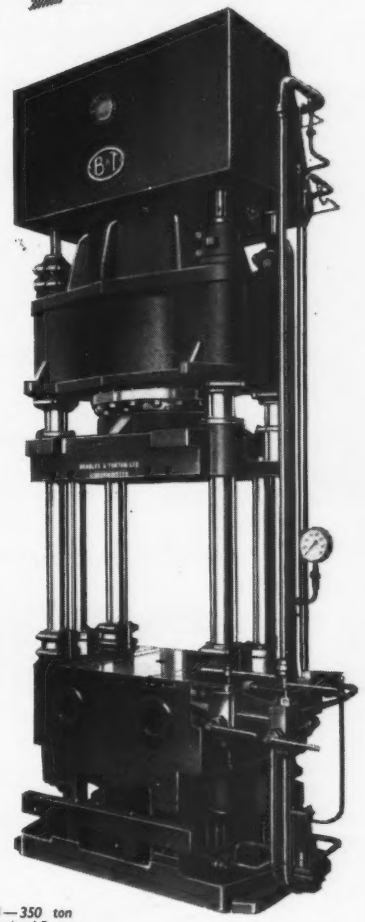

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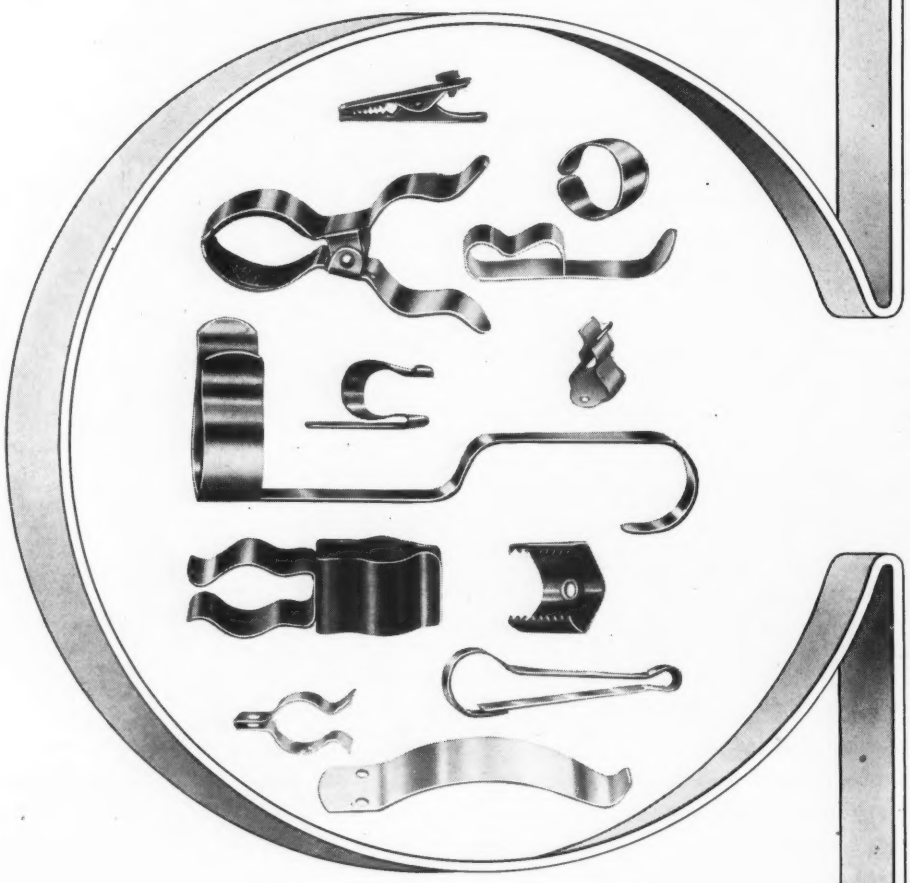

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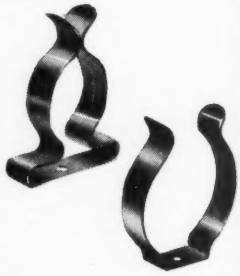
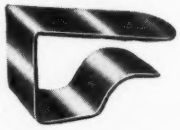
80 and 81 — general utility clips — for tool racks, etc., from ¼" to 2" from stock.



300 — an exceptionally efficient drawing board clip, 5/- a doz. (inc. p.t.) from stock.



257 — a useful clip in black enamel, from ⅜" to 1½".

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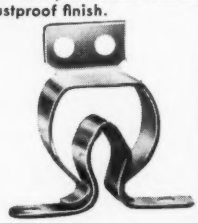

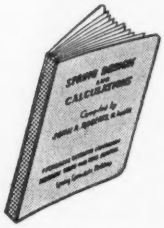

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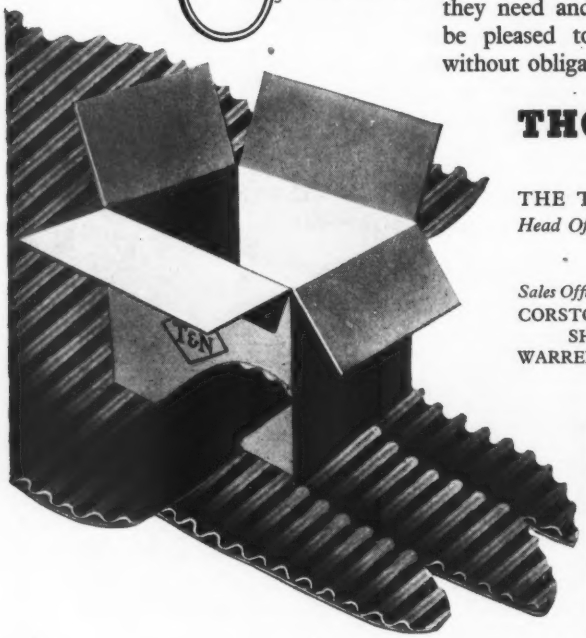

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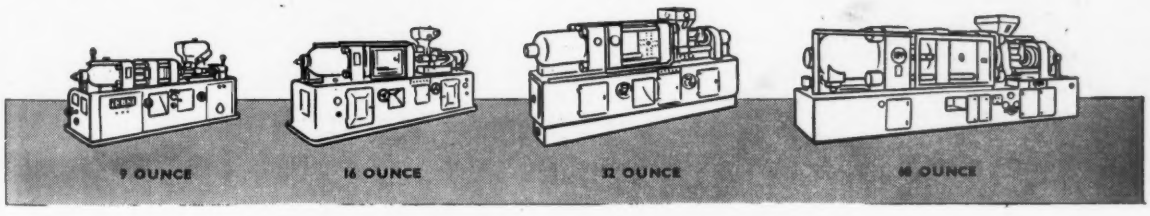

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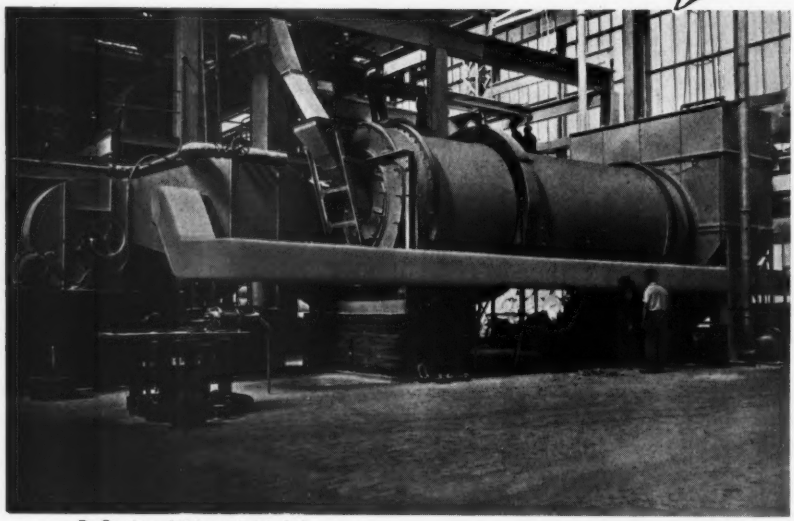

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And the telephone directory?* 'MOULDRITE' urea formaldehyde, for easy-moulding, and fine appearance.

* *'Teledex' manufactured for Paragon Brushes Ltd. by Insulators Ltd.*

'DIAKON', 'WELVIC', 'ALKATHENE', and 'MOULDRITE' (registered trade marks), are all on the I.C.I. range of plastics–the largest in the world from a single manufacturer

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Export enquiries should be addressed to: IMPERIAL CHEMICAL INDUSTRIES LTD., PLASTICS DIVISION *Welwyn Garden City, Herts. England.*

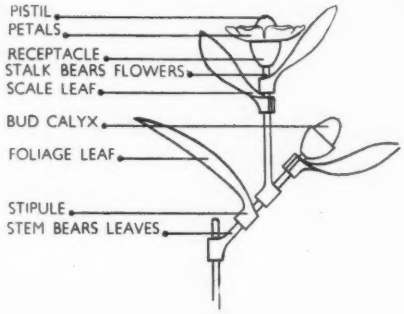
P.518

C

Designer's Diary N.º 9

Reprints of this announcement will be sent on request.

For the second year in succession, A. H. Woodfull, M.S.I.A., Chief Designer of the B.I.P. Product Design Unit, has won the first prize in the annual competition for plastics design sponsored by the Worshipful Company of Horners. This constructional toy was his winning entry in the 1952 competition.



The Product. Although much has been done to provide children with constructional toys which stimulate imagination and develop manual skill, there is still considerable scope for toys with a direct educational value. The toy illustrated aims to foster an interest in botany, since a child needs at least to have an elementary understanding of natural plant growth before being able correctly to assemble the components.

The Design. The split heels of the standard leaf and stalk are a push-fit upon each other. The angles are arranged to provide an infinitely variable arrangement of the finished plant, overcoming any possibility of geometrical appearance.

The pot forms a natural pack for the components. The lid has a raised square platform with a pattern of blind holes which forms the foundation for plant building. The lid is secured by a cam-type locking device, instead of the more conventional threads, so that it can be easily opened and closed by quite a young child ; this arrangement also provides a technical advantage in that both pot and lid can be moulded in straightforward 'up and down' moulds. When completed, the toy need not be dismantled immediately : its after use as an attractive floral decoration would give the child an extra sense of achievement.

The Materials. Beetle urea material, with its excellent colour range, is recommended for compression moulding the body and lid ; ethyl cellulose—a tough material—for injection moulding the stalk and flower units. For the leaves, the leathery 'feel' and natural elasticity of polythene suggest it as an ideal material.

The B.I.P. Technical Advisory Service will assist industrial designers and manufacturers who use plastics mouldings in their production processes. Advice is freely offered regarding product styling, mould design, choice of materials and moulding techniques. The Service exists primarily to assist your own designers and technicians regarding those problems peculiar to plastics mouldings, with which only a specialist can be completely conversant.

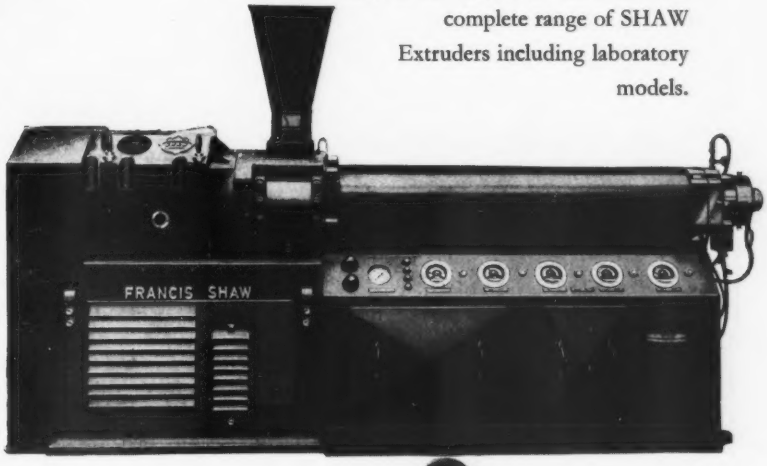
BRITISH INDUSTRIAL PLASTICS LIMITED B·I·P GROUP **1 ARGYLL ST., LONDON, W.1**

'BEETLE' is a trade mark registered in Great Britain and in most countries of the world

SHAW

for extrusions like these . . .

The Shaw 4½" Plastic extruder is specially designed for the continuous production of belting, tubing, miscellaneous sections and for the insulating and sheathing of cables. Also suitable for processes requiring the delivery of a regulated amount of milled and molten materials for sheeting or coating purposes. There is a complete range of SHAW Extruders including laboratory models.



SHAW

FRANCIS SHAW & COMPANY LIMITED
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TELEPHONE: EAST 1415/8 TELEGRAMS: CALENDER MANCHESTER 11
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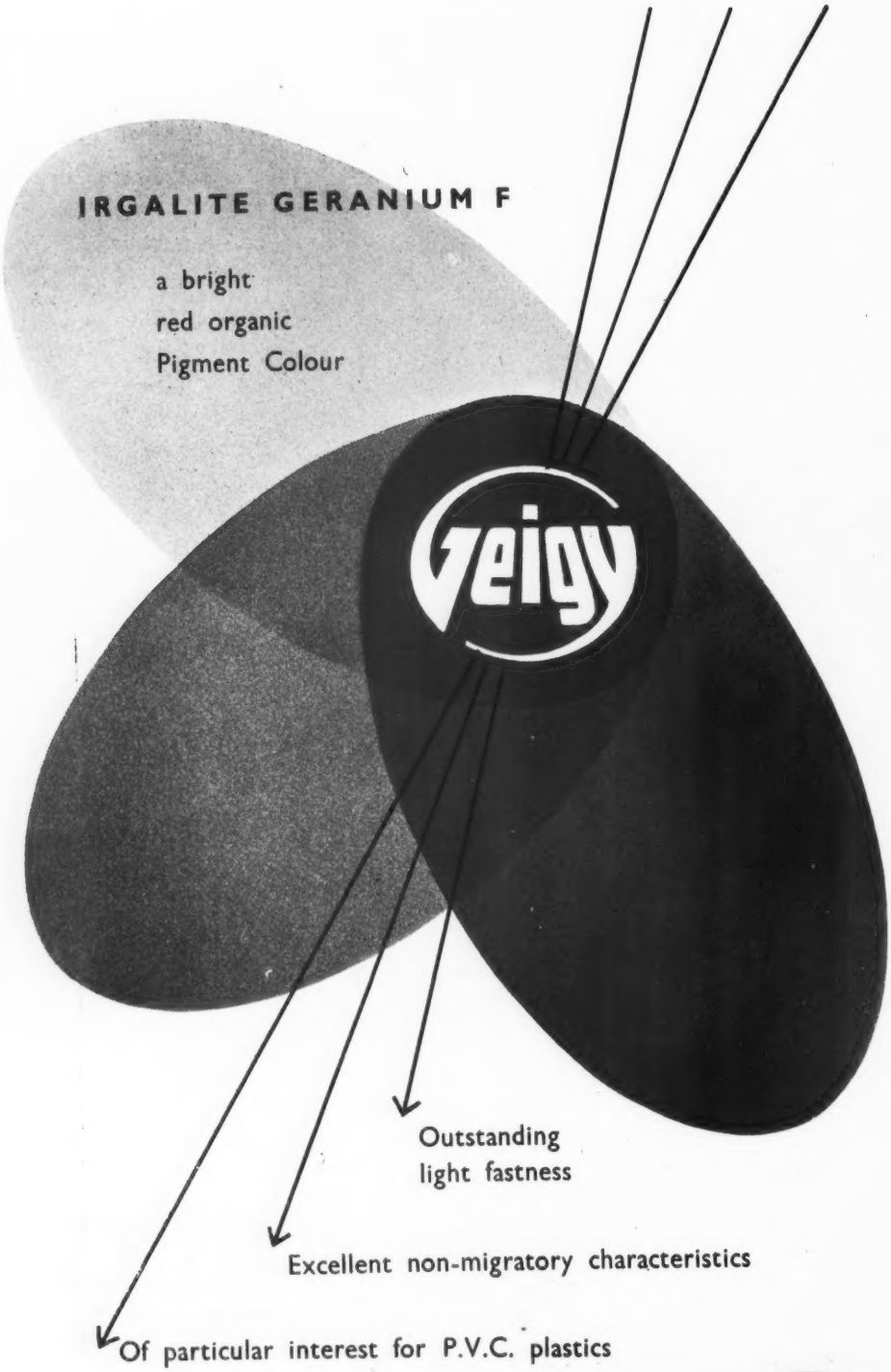
Rooster 2867



GEIGY COMPANY LIMITED . Rhodes . Middleton . MANCHESTER Geigy

N.11c

Shock-Proof

It certainly was not the fault of Venus, poor girl, that the ocean nymphs who had cared for and educated her in the warm depths of the Mediterranean, decided to "bring her out" suddenly on the surface, clad only in her birthday suit.

It was a high shock for her—particularly when, as depicted in that famous picture "The Birth of Venus," little winged cupids blew on her, chilling her yet further. An unkind thing to do.

So, Gentlemen, we will not depict that! Rather we prefer to illustrate how Zephyrus, the soft South Wind, weaved his warm mists around her to protect both her and beholders of the event from all types of Shock—high, medium and otherwise, thereby hoping we shall merit the approval of Censors and all *respectable* people.

★ ★ ★

Today the human race is becoming inured to shocks. Plastic Mouldings need equal protection. Hence the very complete range of "Nestorite" Powders, of which we append a typical example.

NESTORITE **GRADE A.645**

MEDIUM SHOCK

Filler	Cotton
Particle Size (inches)	$\frac{3}{8}$ flake
Specific Gravity	1·37
Bulk Factor	3·0-3·9
Powder Density	·35-·45
Time of Cure of Test Cup (secs.)	55-60
Recommended Flow Range	10-18
Shrinkage (thou./inch)	5·0-6·5
Flowability (cm.)	8-9
Impact Strength (ft./lb.)	·27-·37
Tensile Strength (lb./sq. in.)	6,000-8,000
Water absorption (7 days) (mg.)	100-200
Plastic Yield Grading (°C.)	140
Shrinkage after heating 5 in. disc for 24 hrs. at 140°C. (thou./in.)	3·5
Electric Strength at 90°C. minute value (V/mil.)	40-80
Surface Resistivity after immersion ($\log_{10}$ohms)	9·5-10·5
Volume Resistivity (as moulded) ($\log_{10}$ohm cm.)	10-11
Power Factor at 10^6 c/s.	·05-·06
Permittivity at 10^6 c/s.	5·0-5·8

A fast-curing medium shock material. One of our most consistent and popular standard materials. Can be moulded into a wide range of articles by either compression or transfer.

YOU'RE RIGHT WITH "NESTORITE"

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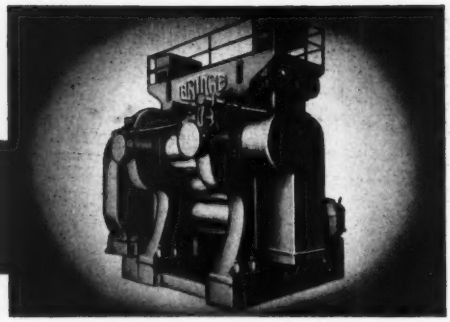
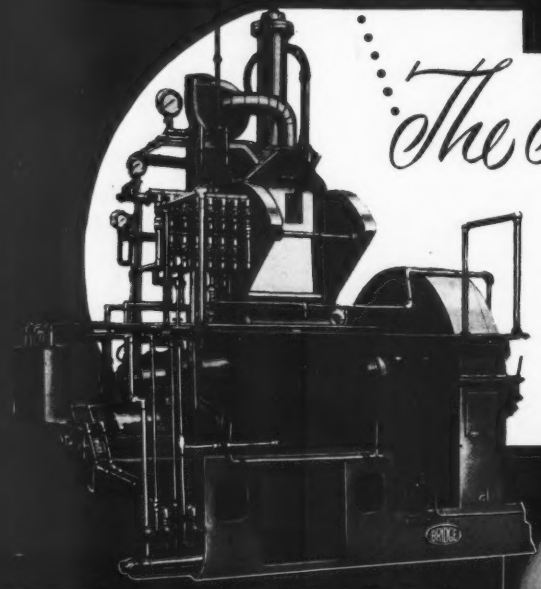
EINAR HOLMARK, 19, Gl. Kongevej,
Copenhagen V, Denmark.

Precision Calender with three superimposed and one offset roller. Flood lubrication.



The Hallmark

of DESIGN, SERVICE and PERFORMANCE *in* **RUBBER AND PLASTICS MACHINERY**

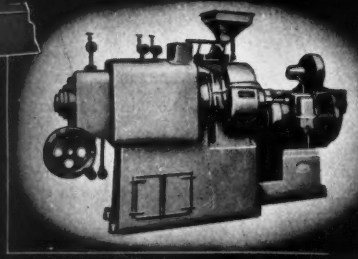


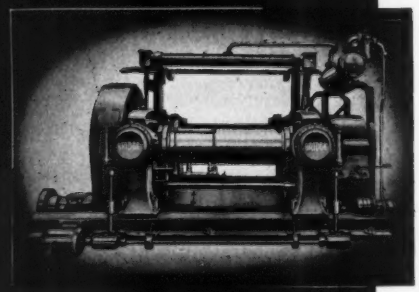
The Bridge — Banbury Patent Mixer. (1)

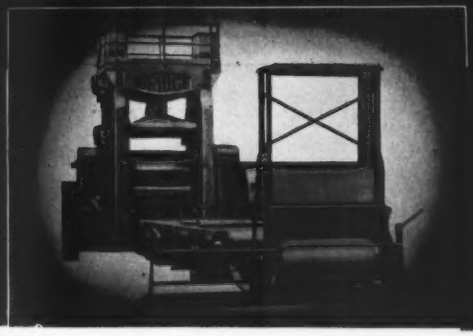
Precision Calender with four superimposed rollers. Flood lubrication. (2)

4½ Cold Feed Plastics Extruder. (3)

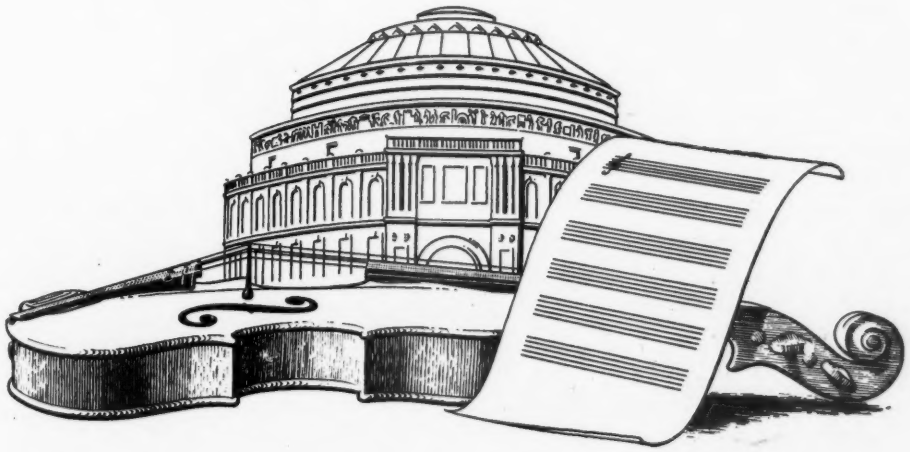
High temperature 22" x 60" Plastics Mill with flood lubrication. (4)







Variations on a theme



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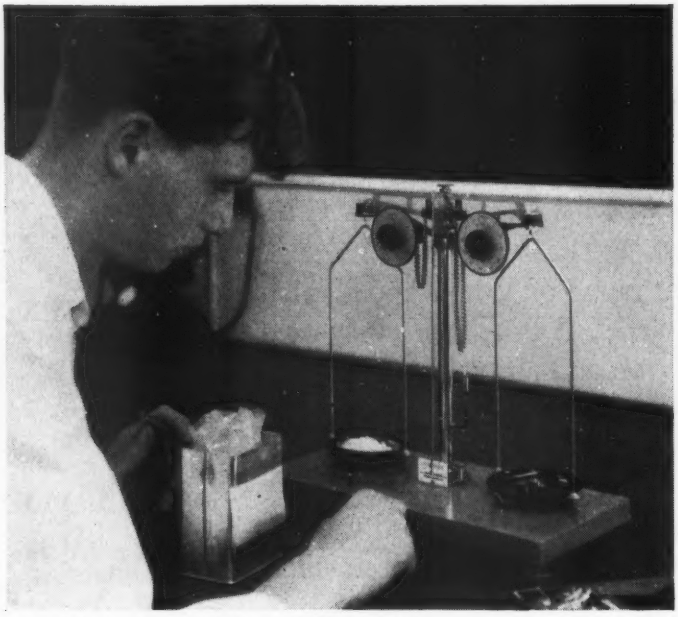
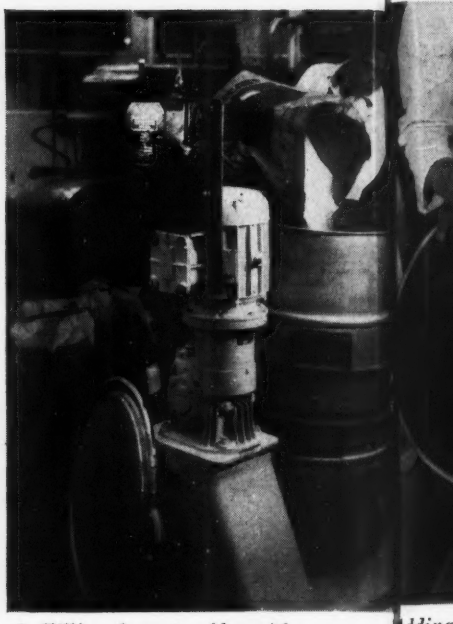


1 *Weighing dye for Colourant Blend mixing.*



2 *Filling drum tumbler with Colourant Blend.*

The LUSTREX* Dry Colourin

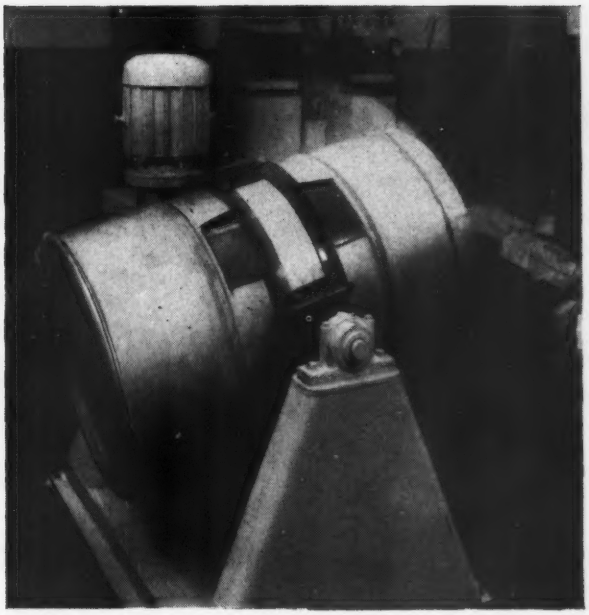
A simple, economical method of colou
polystyrene to any shade you wa

THE economic advantages of Monsanto's Lustrex Colourant Ble
are being more and more widely appreciated in the industry si
the advent of this versatile form of polystyre
The outstanding virtue of Lustrex Colourant Blend is the extreme simplic
with which it can be used in the dry colouring process. The only extra equipm
required is a simple drum tumbler which will handle a charge of 50-150 lbs. of polystyre
and a balance on which the dyes can be weighed. Processing is easy. After mix
under controlled conditions, the dyestuff adheres uniformly to the surfaces
the Colourant Blend granules. The material can then be removed and
directly into the injection moulding machi
Our series of illustrations shows these operations, step by st

But simplicity is not the only attraction of Lustrex Colourant Ble
Consider these points, too

Colouring costs are so low that savings of many pence per lb. can be m
compared with coloured moulding powders. Colourant Blend is supplied
exactly the same price as Lustrex general moulding grade crystal. Any col
can be produced at short notice. This permits greater flexibility of operati

dding dye to Colourant Blend in drum tumbler.



4 *Drum tumbler in operation.*

in rocess

nly a comparatively small stock of crystal need be carried roduce all the shades desired. Leading moulders in the .A. have found it possible to reduce stocks by as h as 75%.

ough the use of Lustrex Colourant Blend, it is now sible to produce — at reduced cost — a wide range of , novelties, houseware and miscellaneous articles which e previously moulded from processed colours.

ormation. Full details and technical information from stics Sales Department, Monsanto Chemicals Limited, will also be pleased to tell you about the many other micals and plastics for your industry. These include: nol, Cresylic Acids, Aroclors*.

*(*Aroclor and Lustrex are Registered Trade Marks)*

5 *Charging the injection moulding-machine hopper with Colourant Blend.*

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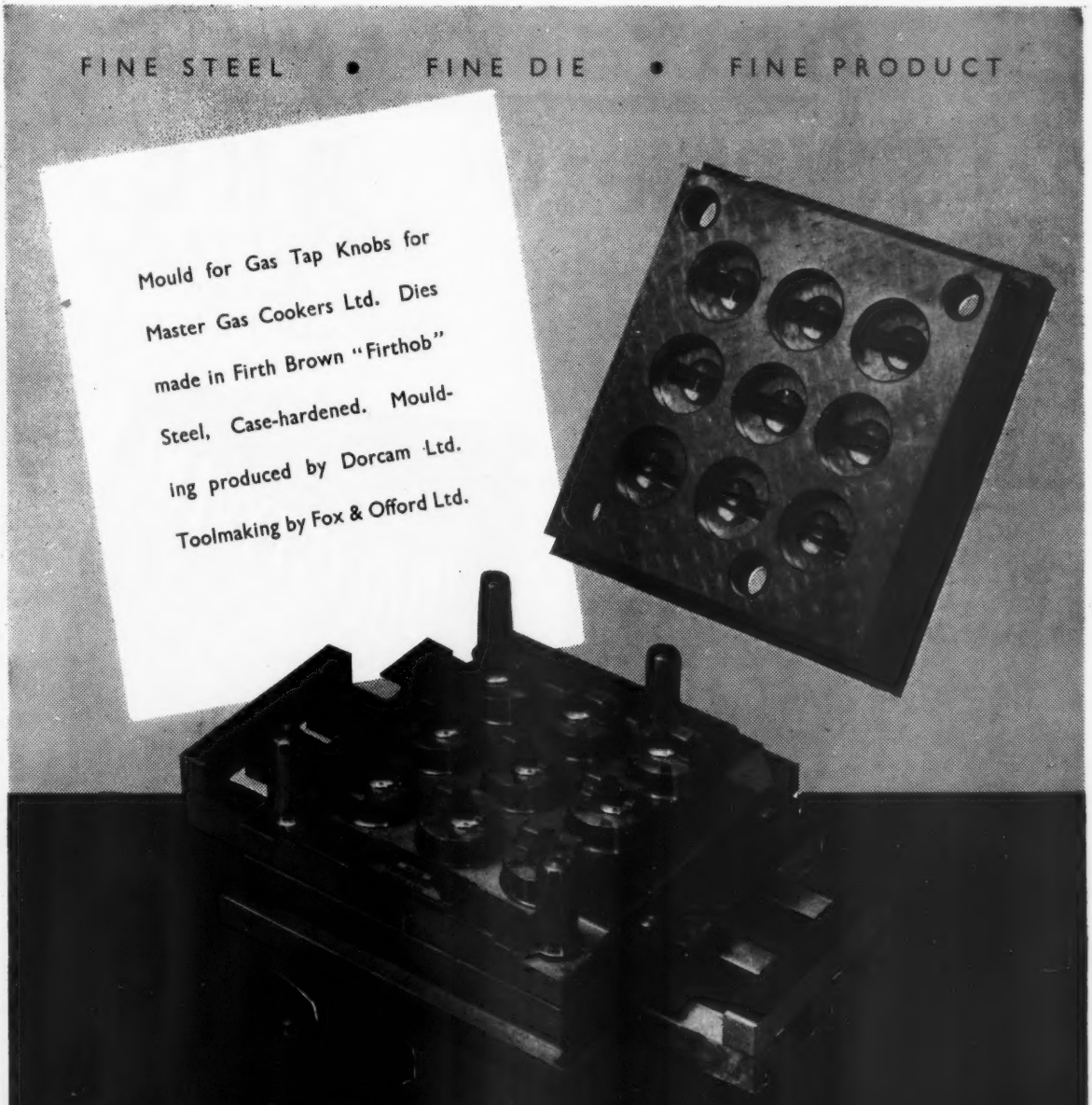

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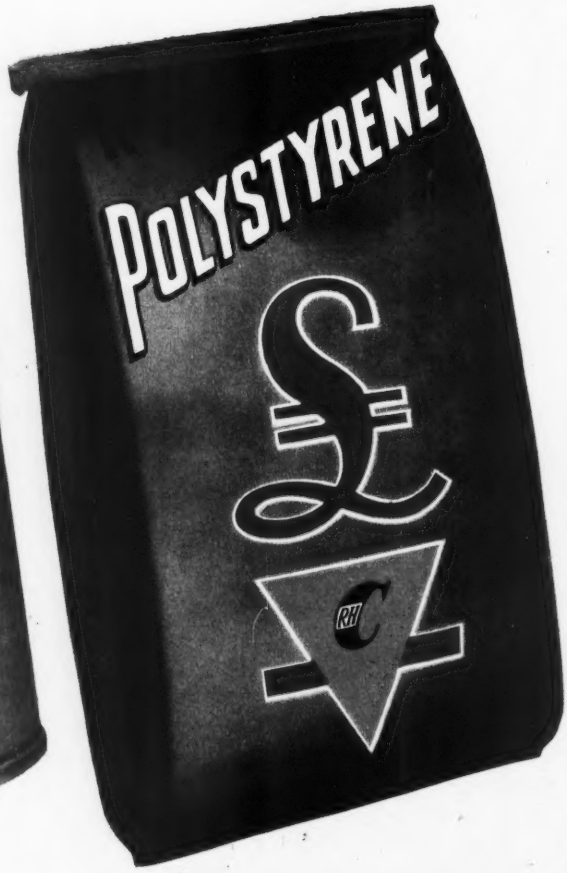

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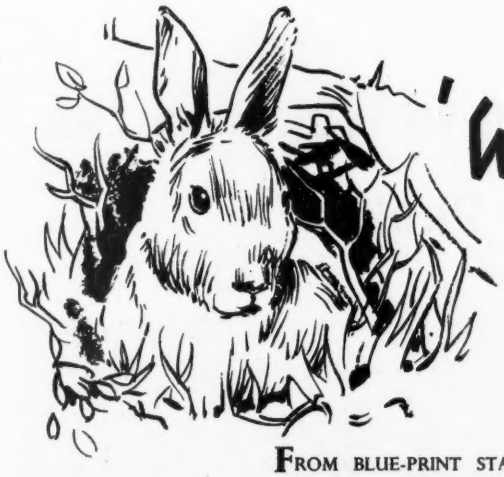

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Whatever you need in plastic mouldings we are confident that we can supply it—we welcome ALL enquiries

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It is common for "FESCOL"-processed Rams to operate for many years without sign of deterioration through wear or corrosion, and with packings unchanged.

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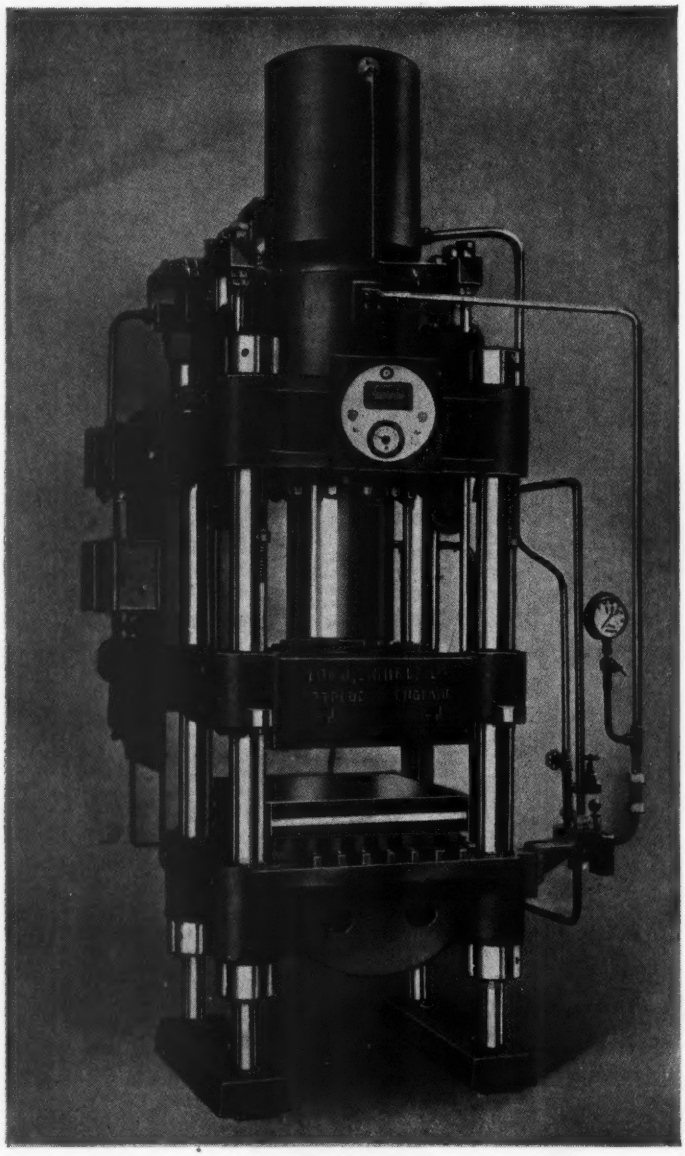
Moulds, also, if "FESCOL"-processed, far outlast untreated moulds. We will be pleased to offer advice on the above and other applications in the Industry.

EXECUTIVES are invited to write for List P.2. which describes the process and illustrates many applications for which it has proved beneficial.



Photograph by courtesy of Messrs. T. H. & J. Daniels, Ltd., Stroud, Glos. The Press is fitted with the Daniels "Time-master" Automatic Cycle Controller.

FESCOL

ESTABLISHED 1920

FESCOL LIMITED NORTH ROAD · LONDON · N7

Branch Works: HUDDERSFIELD, Cable Street · PORT GLASGOW, Industrial Estate

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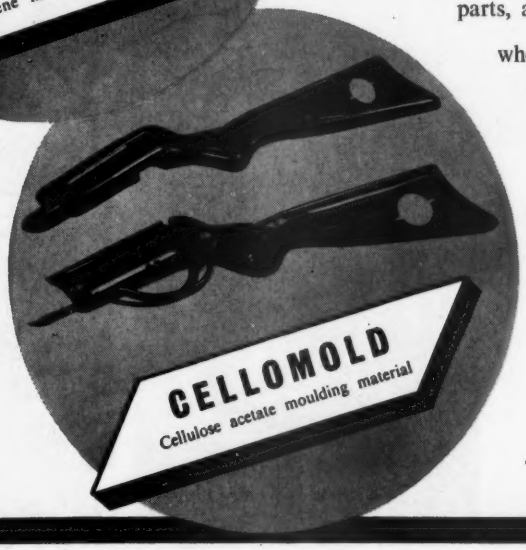
World patents and patents pending. Registered design.

A DOUBLE HIT FOR BRP



THAT the clean lines of this BEEJU popgun will remain straight and true long after its young owner has relegated it to the back of his toy cupboard is assured by the choice of materials from which it was made. Because of its dimensional stability, EVB Plastics Ltd. selected DISTRENE 200 for the barrel and working parts, and used CELLOMOLD for the stock, where extreme toughness was important. These BRP moulding materials are suitable for machines of all types and capacities. Their strength, durability, surface finish and colour range afford scope for applications of the utmost variety. Details and advice on their uses are freely available from BRP.

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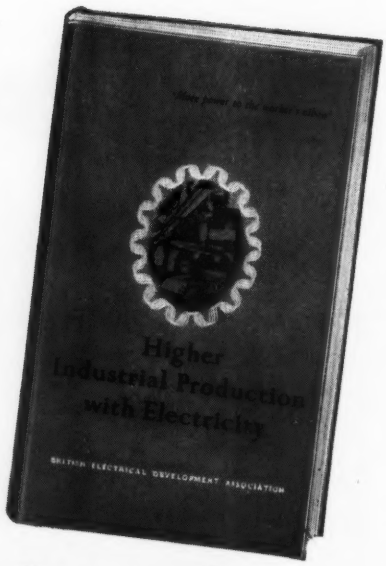


INCREASED PRODUCTIVITY is the chief task facing Industry today, and there are many ways of achieving it. The solution may lie in higher speeds, or more exact control, or more refined methods of heating, or the latest system of inspecting for quality. But in every case, Electricity has an important part to play.

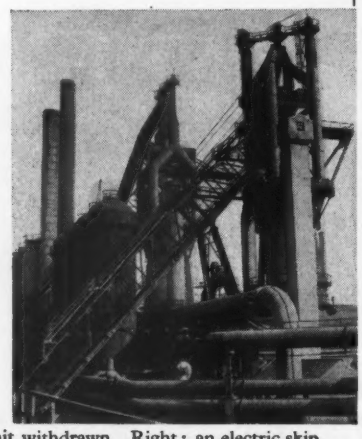
The British Electrical Development Association has published "Higher Industrial Production with Electricity" to help in this vital task. The book is written for management, and for all who are concerned with industrial planning and processes.

There are chapters on Lighting, Motors and Control Gear, Furnaces and Heat Treatment, Welding, Handling, and Inspection. Make a note to get a copy.

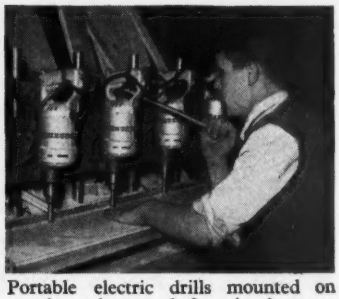
Now ready

"Higher Industrial Production with Electricity", some illustrations from which are shown, is available at 8/6 (9/- post free) from The British Electrical Development Association, 2 Savoy Hill, London, W.C.2 and from your Electricity Board.

An electric stud-welding gun in operation on a dust collector component.



Left: an electronic control cubicle with one unit withdrawn. Right: an electric skip hoist charger for a new blast furnace in South Wales, where the entire hoisting and charging process is automatic—initiated by the pressing of a single button.



Portable electric drills mounted on stands and ganged for simultaneous operation in a Midlands Joinery shop.

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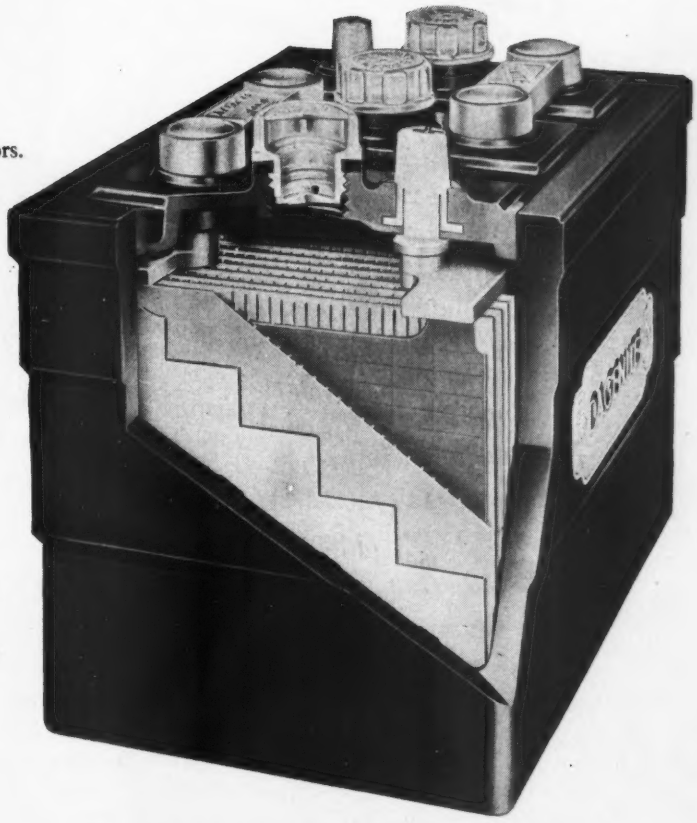
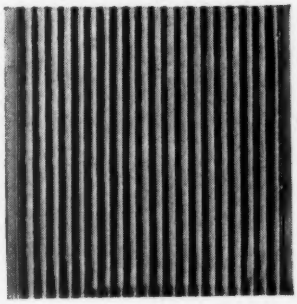
'Corvic' grade H.O. is used by Pritchett & Gold and E.P.S. Co. Ltd. for their 'Porvic' microporous p.v.c. separators. These separators—an outstanding war-time development—are now incorporated in their complete range of 'Dagenite' batteries, giving increased mechanical strength, greater resistance to chemical attack and longer life. This use of 'Corvic' p.v.c. is typical of the important applications for this material which are helping British Industry to make good products even better.





'Corvic' is the registered trade mark of p.v.c. polymer manufactured by I.C.I.

'Porvic' is the registered trade mark of microporous p.v.c. separators manufactured by Pritchett & Gold and E.P.S. Co. Ltd. as illustrated on the left.

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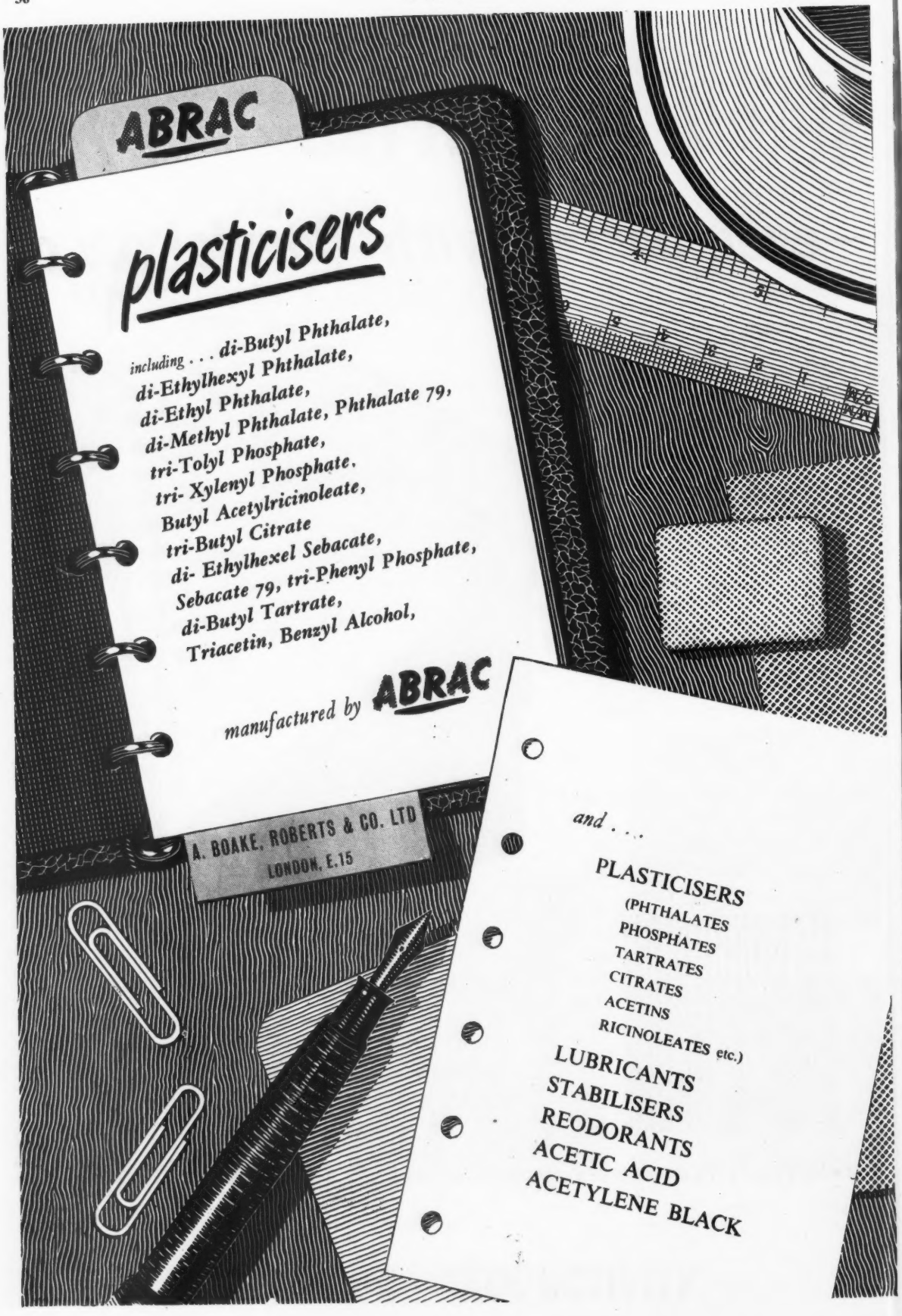
P.W.35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tri-Tolyl Phosphate,
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Butyl Acetylricinoleate,
tri-Butyl Citrate
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TARTRATES
CITRATES
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with INORGANIC FILLERS

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excellent electrical properties,

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L54

Plastics

DEALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

PROPRIETORS: TEMPLE PRESS LIMITED

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The de Havilland Comet Mark I was constructed with extensive use of synthetic resin adhesives (*See page* 107 *of this issue.*)

leaving
plastic mouldings
in the cold

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Plastics

VOL. XVIII. No. 189 APRIL, 1953

EDITORIALS

"Comet" Story

NO doubt it seems strange that a technical development can rouse deep and powerful emotions in a nation normally considered unemotional, but such was the effect on this country when the story of the Whittle development of the jet engine broke upon us during the early post-war years. Perhaps it was the sense of frustration in the victors that peace was not yet at hand and the continued austerity that made us turn to the marvels of a technical advance with renewed hope for our economic future. It gave us a chance to lead a new industrial revolution far greater than that of the 19th century—one that would give us a supremacy in the air as great as that we held so long upon the seas.

Today, we are assured and all other nations agree, that we are years ahead of any other in jet propulsion—that our latest jet fighters are the best and that our "Comets" are the envy of the world.

The story of the De Havilland "Comet" is a special one and significantly different from that of Service aircraft, for its existence and its life depends not only on its superb mechanism but also on the economics of its construction and upon its running costs. To say just that is not very thrilling, but it does entail a story that stirs the heart of any technologist, for it is one of years of research and of boldness and energy in adopting the results in a manner unique in industrial endeavour. We refer to the bonding of metal to metal by synthetic resins, a process that still cannot quite be grasped by a world so accustomed to the limitations of the traditional animal and vegetable adhesives for thousands of years.

It is this synthetic resin bonding that has created a major revolution in aircraft, a revolution that has its greatest effect in high-speed jet transport.

It has long been known that at these very high speeds the slightest irregularity in skin surface is detrimental to performance so that immediately, the bonding of metal to metal in the construction of aircraft wings and fuselage provides an answer without the necessity of employing the difficult and costly techniques of riveting followed by grinding rivets flush.

Economy in fuel consumption demands high-altitude flying for an aircraft such as the "Comet." This in turn involves problems of "pressurization" and whereas riveting involves the pre-drilling of innumerable holes, each to be sealed at a later stage, the synthetic resin bond is in itself an hermetic seal: no holes have been made in the sheets and so no further work is needed before "pressurization." Bonding likewise simplifies the sealing of wings containing the fuel tanks and an enormous weight of fuel.

Low overall weight in relation to payload is vital to the economic work of the "Comet." Here the influence of resin bonding is evident in two ways. First, by giving continuous adhesion over whole areas of contact between sheets, stringers, etc., to be joined, it ensures a uniform distribution of load and avoids the local stress concentrations that are characteristic of riveting and spot-welding. Secondly, the process saves the weight of a very large number of rivets. A corollary is the bonded joints are normally much stronger than metal-to-metal joints made by alternative methods and this property allied with the inherent advantage of bonding which permits thinner-gauge sheets to be used (and so no margin need be allowed for countersunk rivet heads) enables an enormous overall weight-saving to be achieved. Metal-to-metal adhesion with synthetic resin therefore saves not only the weight of many rivets but, more important, that representing the difference in weight between thousands of square feet of thicker and thinner sheet. This difference contributes more than any other factor towards a weight-saving that makes possible an economic payload and it has been stated that, using conventional structural methods, such a payload could not have been achieved.

Further advantages of the process are important to the economics of the "Comet" as to those of any aircraft. Bonding needs a much lower proportion of skilled and semi-skilled labour than alternative methods of joining. The bonding process also obviates the difficulties of gradual mis alignment in riveting along a row. It is too early to estimate the reduction in production costs for the "Comet," but, in its forerunner, the "Dove" air liner, it has been established that the bonding of stringers was one-third the cost of riveting.

Lower maintenance charges are also awaited with interest. No failure of joints has ever been reported in more than 300 Dove aircraft and since riveting in the wings and fuselage is mainly confined to joints between a few exceptionally large sheets, the cost of servicing riveted structures is largely eliminated. Such structures pose intricate and costly maintenance problems to airline operators for many types of failure are difficult to detect by ordinary inspection methods.

Of striking importance is a result of avoiding stress concentrations in joining stringers and sheet, for an important contribution is made towards greater durabilities since bonded metal joints have a high fatigue strength compared with riveted or spot-welded structures. As a result it is expected that the life of the "Comet" in service will be of the order of 10-15 years compared with an average of six years for pre-war air liners.

The story of the "Comet" is therefore two-fold—that of jet propulsion and of the emergence of synthetic resins in a field that has put this country far ahead of any other in air-liner construction. We have often noted in these pages the work of Dr. N. A. de Bruyne, the inventor of the special "Redux" resins and the process employed and of the close collaboration that has taken place in the past 15 years between him and the great de Havilland Company. We owe much to this happy circumstance.

Dr. de Bruyne returned recently from the U.S.A., more convinced than ever that the resin-bonding process of constructing aircraft bodies was the most advanced to date. At a reception in London, held in his honour, he furnished striking figures regarding running costs of the "payable" "Comet" and a theoretical "unpayable" aircraft from a consideration of weight and fuel ratios. We have pleasure in publishing them on page 107 of this issue, for they give a direct and simple explanation of the need for using new techniques in aircraft construction.

Television—Market for Plastics

THE sudden post-war expansion in television throughout the world opened up great possibilities for plastic materials in a manner scarcely dreamed of in 1939—possibilities greater even than in sound radio. Like the radio set it is an electrical

device with its necessary covered conductors, laminated structural supports and spacers, its knobs and frets and on occasion its entire cabinet of moulded material. It goes beyond the radio set in its transparent plastic magnifier and mask and in its plastic protection of the tube within. Furthermore, television seems destined to outstrip radio in popularity and in its use as an instrument for education.

Unesco reports that 55 countries have begun T.V. activities; U.S.A. with 20 million sets has developed most rapidly of all, while Great Britain has 2 million. We are not sure that we are second on the list, for T.V. is sweeping South America—Brazil alone is planning the installation of more than 250 broadcasting stations. *The Daily Telegraph* radio expert reports the possibilities of exports from this country. Transmitting sets have been sold to more than a dozen countries and 6,000 receiver sets were sent abroad last year, the first export period. We were first in the field of television and should benefit by it.

MOULDING POWDER AND SHOT

A year or so ago, I wrote that I looked forward to the day when one could send a bottle through the post without being packed in a wooden container with sawdust around it or without one of the other complicated and costly methods of packaging which common sense and the G.P.O. insist on when sending glass vessels. I was, of course, thinking of polythene bottles, which are quite unbreakable and very light. Today as ever is (let me mark March 20 on my calendar in celebration!) a transparent envelope containing a polythene bottle (photograph herewith) was handed to me by the postman. The addressed

Bottles by Letter Post?

label was simply tied to the envelope and sent thus to me by Walter York—a novel way of telling me that Ekco's have started manufacture and marketing. It's true it was empty, even of my favourite beverage milk, but it makes you (and I am sure the G.P.O.) think, doesn't it?

* * *

On March 4 the members of the moulders productivity team, with honours still thick upon them for having produced an excellent report for the British Productivity Council and for the plastics industry, permitted themselves to be targets for a multitude of more detailed questions thrown at them by a large number of technologists assembled at the British Plastics Federation offices in Piccadilly, London. Among the remarks made on "finishing" was a condemnation by Dr. Redfarn of (if I heard aright) an inference that we should imitate the American industry in forsaking quality for high output. If such a suggestion had been made I should certainly support Dr. Redfarn, but I can find no such thing in the report. What it does say is: "The overall policy of American moulding compahies is to eliminate hand-finishing as far as possible because of the labour cost involved. . . . Refinements of finish are forsaken in favour of high output and the reduction of cost consequent upon it." Elimination of refinements is far from being elimination of quality. Perhaps what Dr. Redfarn fears is that the thin end of the wedge may be hammered home too far. An interesting statement in Parliament recently by the War Minister gives a clear lead on the general subject.

Fewer Frills Please!

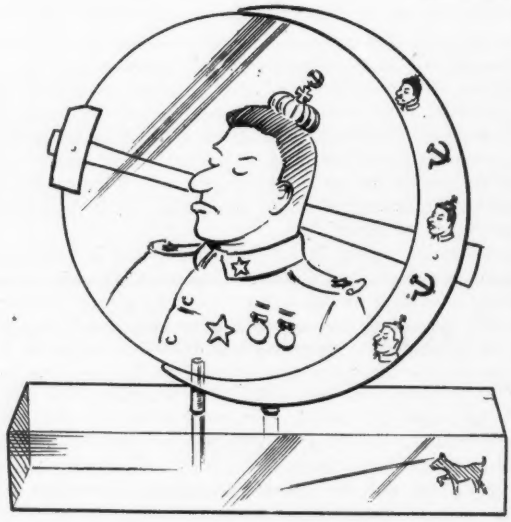
Referring to the saving of £250 already made on each of the Army one-ton vehicles following production examination, he said: "Provided we have adequate performance and serviceability, we cannot afford these additional but less essential refinements which are characteristic of British equipment in the past. I believe it to be essential to get rid of the frills wherever we can."

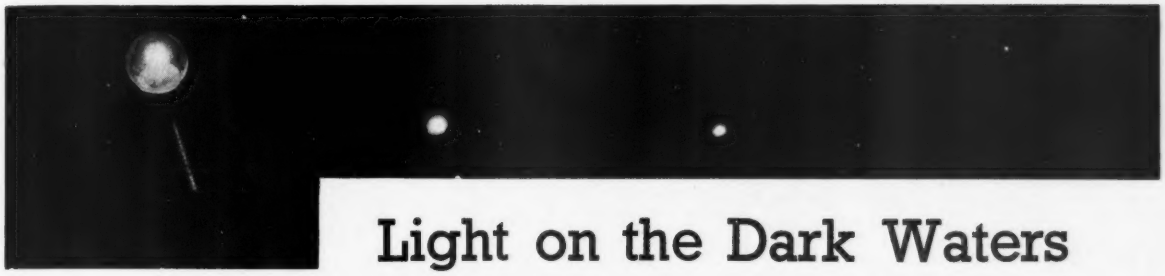
* * *

One or two of the many Coronation designs in plastics that have been submitted to me for my criticism, while often of considerable artistic merit, are not always well-conceived as production projects. The design shown below, entitled "Metempsychosis" and suggested by the author as a paper weight (with detachable paper-knife) to be moulded in transparent polybolonium with four-dimensional decorative inserts, is typical of the work of those creators of pure form with less than adequate knowledge of the limitations of our machines and of plastic materials. The design *qua* pure design, with its insistence of an idealized Majesty, possesses that ineffable je ne sais quoi of the best of the Bessemer-Burne-Jones period with its almost complete suppression of the Ego: yet withal there is visible, in the apparently anachronistic motif, a subtle underlying anarchic symbolism—a primitive struggling that surges ever in the breast of Mankind in its fight against tyranny, oppression and abject slavery and bursts forth as a blazing Light to show the road to Freedom. Available at all stores at 2s. 9d. (inclusive of purchase tax). Attachable ash-tray, 8d. extra. I forgot to mention my technical criticism. The fixing of the 2½-lb. hammer which is spot-welded to the main thingummy-jig, is not in the best British tradition. I would much prefer the use of three 2-in. screws, the middle one, for obvious reasons, to be placed just behind the Emperor's left ear-hole.

Critique of Pure Reason

DOGSBODDY.





Light on the Dark Waters

Notes on a new floating marker for sea-rescue work

THE hazards of life at sea both in peace as well as war have always made the great maritime nations of the world conscious of their duty to protect those who sail the seas and to help them in time of shipwreck. Today the dangers are shared by aircraft that cross the oceans.

While radio has contributed so much in giving immediate warning in a two-way direction—of warning of coming storms and, in case of actual disaster, of pin-pointing positions of ship or aircraft, yet of all the terrors that befall the shipwrecked the greatest arises at night when searches, even in a very restricted area, may fail through absence of light signals or their lack of efficiency. There have been many inventions of light signals ranging from powerful rockets and Very lights whose effects are but momentary, to the continuous electric light provided by the simple torch and the more modern floating marker. There is ample room for continuous research work in all the types.

The details of one of the most recent advances in the latter type have now been disclosed by McMurdo Instrument Co., Ltd., whose activities we have already noted in this journal and who have devised a number of small units for various types of rescue work that are brilliant in conception.

Of the many requirements of such devices which include the ability of the source of light to begin through contact with water, of paramount importance to the whole system of a floating marker of the electric type, is a method of ensuring very long life in storage. And of course—the ability to float. Both the last two essentials have been assured by the use of polythene with its exceptional high surface tension to water and low specific gravity (0.94).

McMurdo Instrument Co., Ltd., has produced a number of different units all based on the same basic principles. Two are described below. The electro-chemical system itself consists of a silver chloride positive plate and a magnesium negative plate using water, either fresh or salt, as the electrolyte. The small light bulb which is thus activated on immersion in water, is of 0.25 watt rating (approximately 2 lumens).

One type (L.5) weighs 20 grammes ($\frac{3}{4}$ oz.), is 3 in. long, $1\frac{3}{8}$ in. max. diameter, and can be thrown at intervals, into the sea or in batches when searching for objects lost, or by castaways. As the time of burning is a minimum of five hours, the effect of tide is not a disadvantage since a string of such lights will lead to the point of origin. Supplied as part of the equipment of lifeboats, rubber dinghies, submarines, they are immediately available for distress signalling. As will be seen from the photograph the whole encasement is of polythene, the design being carried out so that the total specific gravity of metal plus polythene unit, is still under 1 and so that the metal plates lodged in the " keel " and exposed to the water, maintain a vertical position.

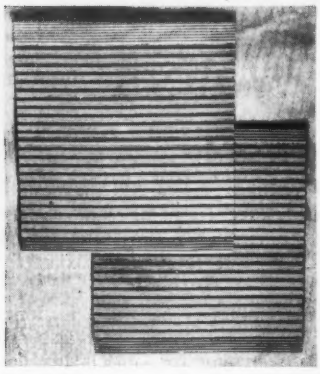
The second type (L.8), also shown, is designed for use on civilian escape jackets in aircraft. The batteries are assembled dry, enclosed in polythene and sealed with two polythene buttons which are pulled off by the ripcord to make the battery come to life on immersion in water. These polythene buttons do not form a perfect hermetic seal, but since only polythene is used in the casing construction, damp air entering the battery cannot cause deterioration because it is unable to bridge the gap between positive and negative plates. Indeed, the shelf life of this (and of type L.5) is regarded as " infinite."

The L.8 unit is connected to a flash-lamp housed in a watertight holder with a clear plastic dome which is attached to the escape jacket in a prominent position. The time of burning is 8 hours minimum. The battery is $4\frac{3}{16}$ in. x 1 in. x $\frac{3}{8}$ in. in size, the whole unit weighing 50 grammes ($1\frac{3}{4}$ oz.).

The L.5 type floating marker. The " keel " (the lower half of the marker) contains the positive and negative plates.

The L.8 type. The flash lamp is attached to a lifebelt; the rip-cord is pulled and the battery case immersed in water.

Fig. 1 (right).—General layout of the Porvic plant, showing extrusion chambers in the foreground, with solvent extraction tunnels and compounding mixers in the background. Fig. 2 (below) Two battery separator plates.



PORVIC—
The Manufacture of Microporous P.V.C.

The search for a reliable, efficient and readily available material to replace wood for separating the plates of lead-acid batteries, has led to the development of Porvic, a microporous polyvinyl chloride sheet. The outstanding properties of this material are giving longer storage and service life to batteries and has enabled the design of more efficient and less bulky units particularly for the Services. Other potential uses of Porvic including filtration, electrolysis and aeration are being investigated and show successful results. Porvic has been developed by Pritchett and Gold and E.P.S., Ltd., and is now being manufactured in several of the company's plants in Britain. Last month we visited their Dagenham works and saw the operation of a large self-contained production unit designed for the manufacture of Porvic separators. Some notes on the manufacturing process and the uses of the material are given here.

THE present large-scale production of Porvic microporous polyvinyl chloride battery plate separators is the culmination of over 10 years' work by Pritchett and Gold and E.P.S., Ltd., the oldest battery manufacturers in Britain. Until recently, it has been customary to employ sheets of ribbed wood to separate the faces of adjoining plates. Certain species of wood, particularly Port Orford cedar imported from North America, when machined to shape and treated to remove natural resinous ingredients, have proved suitable for this work, giving support to the battery plates and keeping them in alignment, while possessing such a high degree of microporosity that the electrolyte has free contact with the whole surface of the positive and negative plates. These wood separators were, however, subject to chemical attack within the battery and thus gradually deteriorated throughout its service life and could fail before the useful life of the battery plates.

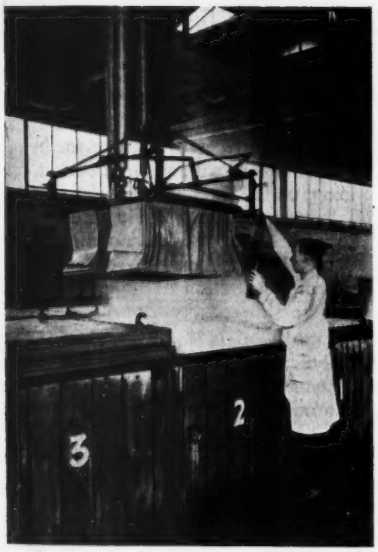
In addition to these service limitations, the difficulty and cost of importing suitable grades of timber, particularly in war-time, intensified the search for an alternative.

The present product is made from an unplasticized polyvinyl chloride resin (Corvic HO, manufactured by Imperial Chemical Industries, Ltd., Plastics Division), which is processed so as to give a uniform sheet with a controlled proportion and size of pores which freely allow the passage of gases and liquids. The porosity is in the form of a large number of uniform spherical orifices interconnected in all directions by openings into adjacent orifices. The size of the orifices as well as of the interconnecting gaps can be varied by changes in the processing ingredients, but a standard grade of Porvic has orifices of approximately 0.015-mm. diameter and interconnecting gaps in the order of 0.001 mm. This structure gives an overall porosity of approximately 85%, i.e., only 15% of the volume of Porvic consists of solid material.

The way in which this type of porous structure is obtained is described in a number of patents, British patent 565,022 being typical of the basic process. Essentially the process involves the extrusion of a mixture containing the resin, a solvent for the resin (such as dimethyl cyclohexanone or isophorone) and a pore-forming ingredient of controlled uniform particle size. Starches have been found most useful and consistently uniform in size as the pore-forming ingredients, but certain salts, prepared by spray drying, have also been used. The solvent is driven off from the extrusion and leaves the starch/resin mixture ready for treatment in dilute acid to hydrolize and leach out all the starch particles and leaving a uniformly porous substance.

Early experimental productions of Porvic were eagerly taken up by the Services, particularly for use in dry-charge batteries which were to be kept in storage for long periods prior to filling for use. The stability of Porvic under these conditions proved extremely valuable and a small production unit was set up to meet this demand. Since then many production increases have been made to cope with the continuously increasing demand, and the £500,000 Porvic production shop at Dagenham illustrated in these pages is one of the most recent of these factories.

The general layout of the Porvic factory is seen in Fig. 1 which shows the containers for the two hydraulic extruders in the foreground with the solvent extraction ovens at the extreme sides. In front of these ovens on both sides are two banks of mixers for preparing the extrusion compound and stretching into the background, with vapour rising from them.



Stages in the manufacture of Porvic, microporous p.v.c. battery separators :

Fig. 3 (above, left).—The compounded dough of p.v.c. polymer, solvent, pigment and pore-forming starch particles is removed from the mixer and taken to the batch extruder.

Fig. 4 (above, right).—The plastic dough is extruded from a specially designed press. A batch of dough is placed in the steam-jacketed chamber (foreground) and forced through an orifice by an upstroking hydraulic ram. Ridges are formed by calendering between rolls. The front of the solvent extraction oven is in the background.

Fig. 5 (left).—Extruded sheet is festooned in loops on to racks which are conveyed to the leaching tanks by overhead hoists.

Fig. 6 (right).—Cut lengths of Porvic are passed through a final drying oven.

Trimming and inspection of battery separators : Fig. 7 (left).—Strips of Porvic are trimmed to correct width. Fig. 8 (centre).—The cut separators are checked for thickness. Fig. 9 (right).—Inspection for pin holes and check for dimensions are made by examination against an illuminated screen.

are the two leaching tanks. Mixing, extruding, solvent evaporation and leaching is carried out in two separate parallel production units as shown.

The two extruders are supplied with the compound by 20 of the rotary blade mixers. These have been designed and manufactured specifically for the compounding of the mixture of resin, solvent, pigment, and pore-forming starch particles. When working at high temperatures they must be completely closed to prevent loss of solvent. The pigment used, carbon black, gives the final product a light grey colour and serves to mask slight colour blemishes which could arise in the normally white resin.

After two hours' compounding, a batch of some 120 lb. of resin/starch mixture is placed into the steam-jacketed extrusion press and is forced out by the up-stroking hydraulic ram. The resulting ribbon is calendered between rollers to give the correct shape and size of ribbing; for ease of manufacture a double width, enough for two battery plates, is extruded in one operation. The ribbons are festooned in deep loops on to glass rods and placed on racks which travel through the solvent extraction tunnel. The solvent is led back to a modern solvent recovering plant from which approximately 80% of the solvent is recovered.

The racks are conveyed through a series of tanks (Fig. 5) containing boiling water and dilute sulphuric acid which hydrolize the starch particles to sugar which is then leached out. After this process the extrusions are cut into strips 3 ft.-4 ft. long and passed through a normalizing oven which relieves any stresses or distortion in the material. Since polyvinyl chloride is a hydrophobic substance the sheets are given a treatment with a wetting agent which ensures that the pores are easily penetrated by the battery acid when batteries are first filled and put into operation. A final drying is carried out in a Lister drying oven fitted with continuously moving conveyors designed to grip the sheets at the incoming end (Fig. 6), releasing them at the "dry" end. The sheets are then trimmed for width, the double width being split. Trimming is carried out on mechanical jigs and cutting to length on a slow rotating slitting machine.

For final inspection the separator plates are checked for thickness (Fig. 8), and for surface dimensions and pin holes (Fig. 9).

Improvements in Battery Design

The introduction of Porvic as a battery separator material has made possible many advances in battery design. Most important of these is the fact that batteries can be assembled dry, and due to the inertness of the plastic separators can be sealed and stored dry for a period of years before being filled with acid and put into service. This was not possible with the conventional wood separators since their action was dependent on their being fully immersed in liquid, dry storage leading to warping and deterioration.

More effective protection of the plates is also possible since Porvic can be formed under heat around a plate and cemented to make a completely sealed envelope. By far the most important advance, however, is the complete inertness of the material so that the life of the batteries is no longer determined by the length of time for which the wood can stand up to the acid but is now controlled entirely by the length of life of the plate itself.

Other Applications

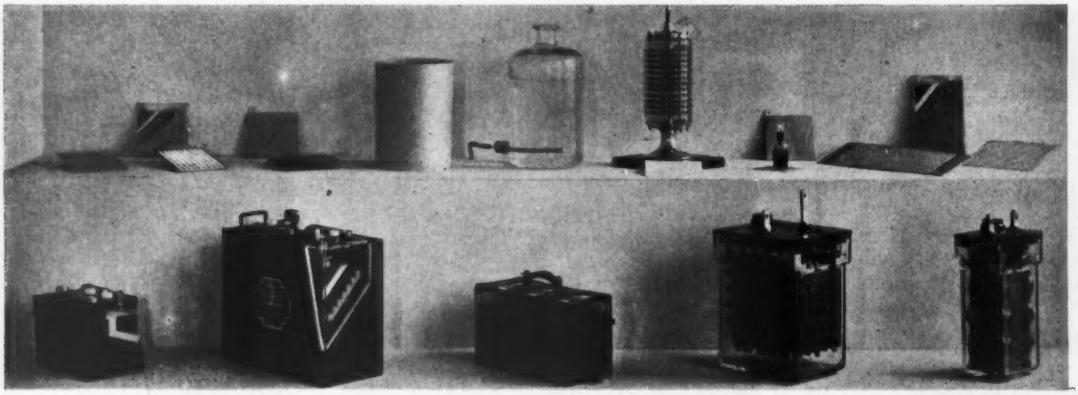
Although Porvic was originally developed as a battery separator it has been found that this microporous thermoplastic diaphragm has other uses. In fact, it is now evident that its success as a battery separator is an indication of its value in many other fields.

The fact that it has not been freely available until now has hampered the development of other applications for this microporous material, but it is certain that many fields of industry could make use of Porvic or similar materials developed on the same lines. The completely uniform and controlled size of the microporosity which can be varied to suit specific applications is of particular interest for various filtration processes and a small filter unit is illustrated below. Uniform aeration of liquids is also possible by using the material and developments are being carried out for utilizing this property. One further use at present being developed combines a strip of Porvic with sintered bronze for use in an aircraft de-icing unit. This unit works on the principle of a steady discharge of de-icing liquid through the pores in the bronze material fitted on the leading edge. The porosity of the sintered metal alone has proved to be too uneven, and a more uniform distribution of liquid has been made possible by backing the sintered bronze with a Porvic inter-layer.

Separators for electrolytic cells also appear to have advantages over previously used materials and are being adopted in a number of processes.

Experimental work is being continued in the laboratories of Pritchett and Gold and E.P.S., Ltd., to produce variations on the basic Porvic material, e.g., by incorporating plasticizers.

New ideas for applications of microporous materials are being investigated in collaboration with users, and the company is ready to co-operate in developing suitable products.



Some examples of Porvic for battery separators and other uses. The top row includes battery plates sectioned to show the separator, a cylindrical diaphragm for an electrolytic cell, a Porvic tube inserted into water to show uniform aeration and a multi-plate filter unit employing Porvic filter plates. The bottom row shows Dagenite batteries for cars, commercial vehicles and aircraft, all fitted with Porvic separators. The two cells made for switch operation (bottom, right), one using wood separators, the other Porvic, show the saving in bulk and weight for the same performance.

The Future of Jet Aircraft

Dr. Norman A. de Bruyne of Aero Research Ltd., has returned from the United States of America where he discussed with aircraft manufacturers, designers and other technologists the bonding of metal and other structures with synthetic resins with special reference to the "Redux" process as applied to jet aircraft construction. On March 17th he held a reception at Londonderry House, 19, Park Lane, London, and spoke of the great difference in constructional methods of producing jet air-liners in this country as exemplified by the de Havilland Comet and those being carried out generally in the U.S.A. His remarks are summarized below.*

THE coming of the jet engine has brought many headaches to the aircraft designer and they are forcing him to use new methods of construction. Riveted structures are going out. In America progress has been made in the production of integral skin and stringer panels by machining 60% or so of the metal out of the solid; experiments have been made with casting magnesium-alloy stringer skin panels. In this country we have developed along different lines; we are sticking our metal aircraft together by means of the "Redux" process.*

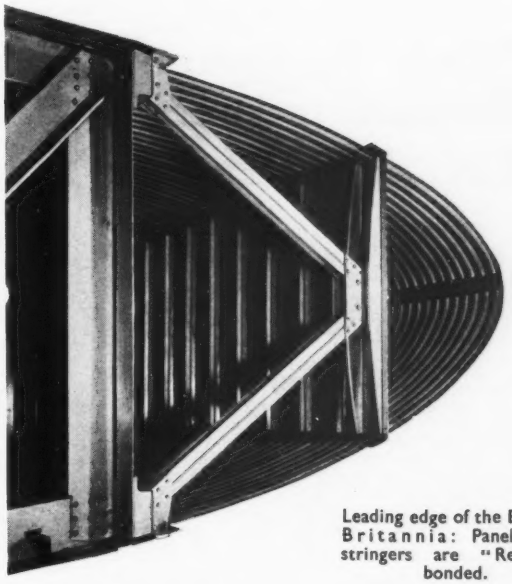
To illustrate the necessity for new methods of construction, he referred to the following figures, representative of the Comet Mark I given on the left-hand side of the table below:—

Comet Mark I		Comet Mark N.G.	
E/W	45%	E/W	48%
F/W	42%	F/W	42%
Pay load	14,000 lb.	Pay load	14,000 lb.
Fuel load	44,000 lb.	Fuel load	52,500 lb.
Empty weight	47,000 lb.	Empty weight	66,500 lb.
Gross weight	105,000 lb.	Gross weight	133,000 lb.

Note: E=empty weight, W=gross weight, F=fuel load

Now using a simple analysis due to Dr. A. E. Russell, of the Bristol Aeroplane Company (Inst. Prod. Eng J. 32, Feb., 1953, 86-94), we can see what the economic consequences are of pushing up the E/W ratio to 48% while retaining the same performance as the Comet Mark I. We then get the figures shown under the heading "Comet Mark N.G." on the right-hand side of the above table. On comparing the two sets of figures we note that the empty weight has gone up by 19,500 lb. that is to say, this small increase in E/W has resulted in a much heavier and more powerful machine and the hypothetical Mark N.G. will cost the purchaser £9 × 19,500 (£175,500) more; this is only the beginning of his troubles because, according to information supplied by Mr. Peter Masefield, of B.E.A.C., the annual operating costs will be increased by £50 × 19,500, which is getting on for a million pounds a year! It is perfectly clear that the Comet Mark N.G. will find no buyers and probably had "Redux" not been used, the Comet Mark I E/W might well have been 48% or even more. These fantastic figures arise, of course, because of the enormous fuel load which the jet engine requires, with the result that the pay load is a very small difference left over after the fuel has been taken on board.

* "Redux" resins are phenolic (resorcinol) in character.



Leading edge of the Bristol Britannia: Panels and stringers are "Redux" bonded.

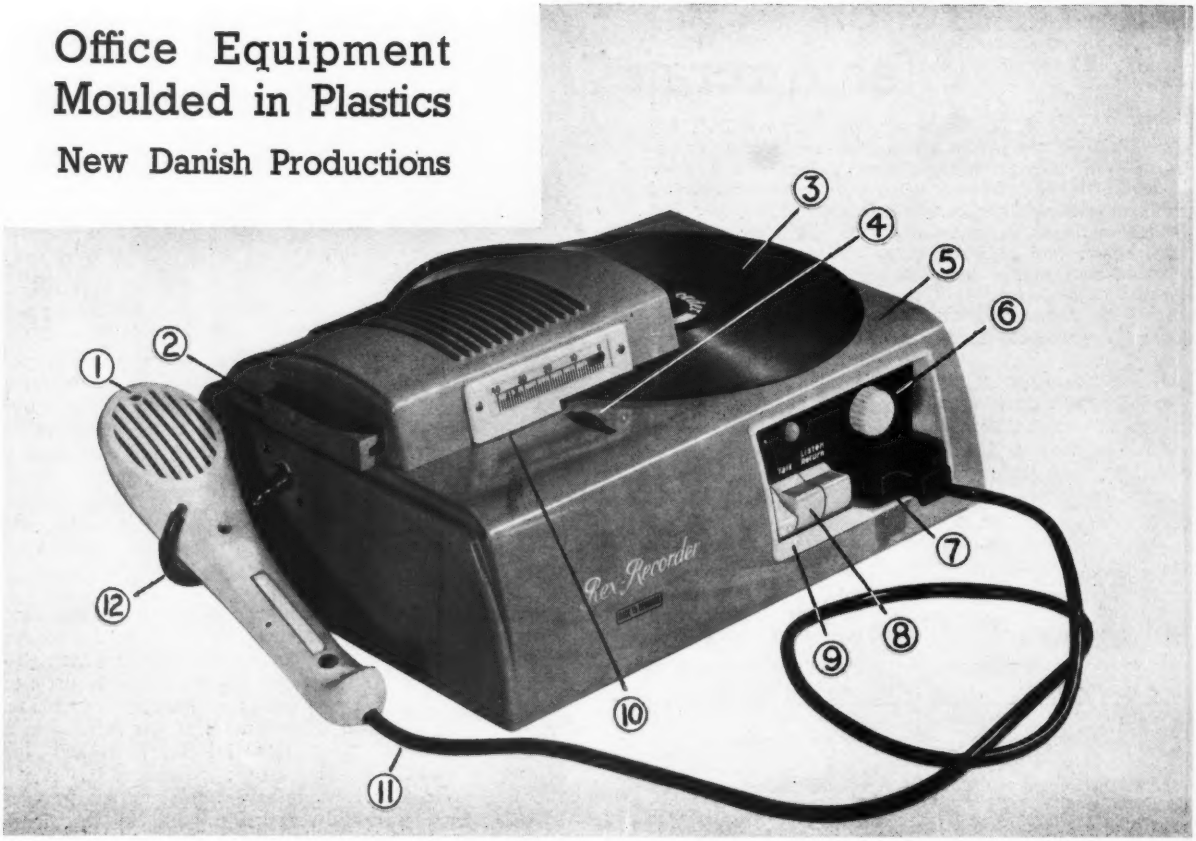
"Redux" bonding will do much more than save weight.

It simplifies pressurization (see left) and it enables smooth surfaces to be obtained. It greatly reduces production costs as we can readily visualize from the large wing panel 23 ft. × 30 in. wide shown above. "Redux" bonding also greatly increases fatigue strength, produces integral and not "sewn together" structures; hence the great increase in static strength.

Comet cabin looking aft, Pressure Dome windows and all stringers are "Redux" bonded, facilitating production of smooth surfaces and pressurization.

Office Equipment Moulded in Plastics

New Danish Productions



Key to Fig. 1 above: 1.—Microphone: Polystyral (Swedish). 2.—Magnet. 3.—Recording disc: p.v.c. (German). 4.—Phenol formaldehyde (British). 5.—Urea formaldehyde (Swedish). 6.—Phenol formaldehyde (British). 7.—Phenol formaldehyde (British). 8.—Urea formaldehyde (British). 9.—Cellulose acetate (British). 10.—Cellulose acetate (British). 11.—Flex: p.v.c. (British). 12.—P.v.c. (British).

MECHANIZATION in the office brings new problems to the equipment designer. Electrical components have to be satisfactorily insulated and, within limits, equipment should be sufficiently light to be moved from place to place by female staff. Again, attractive appearance is today a much more potent factor in a sales campaign than was the case at the turn of the century. Equipment designers have anticipated the growing tendency towards planned and attractive looking offices, and streamlining has been applied to yield the sleek outlines, of, for example, the modern typewriter and the steel desk.

This trend has been responsible for the increased use of plastics materials in the manufacture of office equipment. By virtue of their special properties they satisfy electrical and mechanical demands and provide also for the smoothness of line which is of such importance.

It always gives us pleasure to encounter a piece of equipment which is virtually possible only because of the employment of plastics, and particular pleasure when the use of the materials has been sensibly thought out. Two machines have recently come to our attention which we feel express admirably the proper use of synthetic materials to enhance the products concerned.

Illustrated above is the Rex recorder, manufactured in Denmark and employing a startlingly high number of plastics components. As will be seen from the key above, the materials concerned originated in four countries, all moulding being carried out by various Danish companies. The use of a urea powder for the housing proper has given an attractive moulding pearl grey in colour and strictly functional in appearance. Fig. 2 shows the interior of the cover and illustrates the intricate tool design that was necessary; the strengthening webs can also be seen.

The recording disc is of p.v.c. material manufactured in Germany and the removal of an unwanted recording is effected by passing a simple bar magnet across the disc surface.

The result is a compact unit which, despite its size, can be comfortably carried in a specially made container, due mainly to the employment of plastics materials.

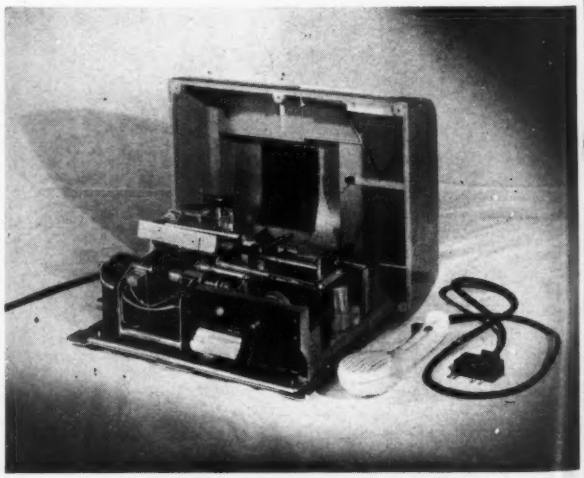


Fig. 2.—Recording machine with cover removed. Many of the electrical parts are insulated with plastics.

Fig. 3 (left).—Contex adding machine. Weighing just over two pounds, the cover, keys and action bars are manufactured from plastics materials. The use of urea formaldehyde for the cover ensures that the machine can be manufactured in a wide range of attractive colours.

The Contex adding machine shown above is also of Danish origin. Here, the cover is moulded from urea in a variety of colours. As will be seen in Fig. 4, threaded inserts are moulded in as well as recesses to carry rubber pads. The sight glass, curiously, is plate glass and not acrylic material.

Figs. 5 and 6 show the machine itself with the cover removed. The keys are moulded in urea and the bars on which they are mounted are of Delaron material manufactured by De La Rue Ltd., London. It will be noted that the bars are pivoted on one common axis. They are machined in London, each having a set of cut teeth which mate with a metal cog which transmits pressure applied to the keys into the adding mechanism. The spacer bars are also fabricated from Delaron.

The total weight of this efficient adding machine is just over two pounds which means that it is completely portable. This again is due to the employment of plastics materials.

We are indebted to Office Machinery, Ltd., 22 Kingly Street, London, W.1, for their assistance in the preparation of this illustrated review. The Danish manufacturers of both machines are Zeuthen and Aagaard A/S, 6 Toldbodvej, Copenhagen, Denmark.

Fig. 4 (above).—View showing underside of cover.

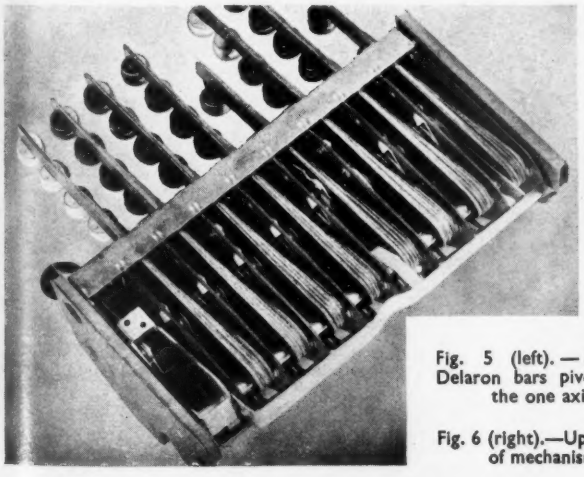


Fig. 5 (left). — Showing Delaron bars pivoted on the one axis.

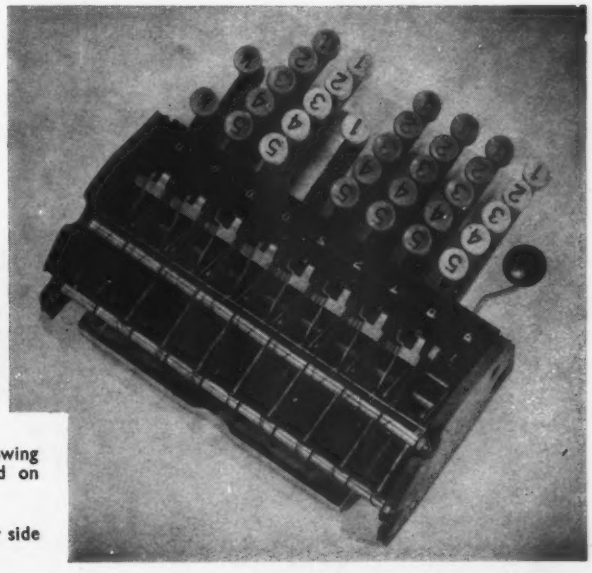
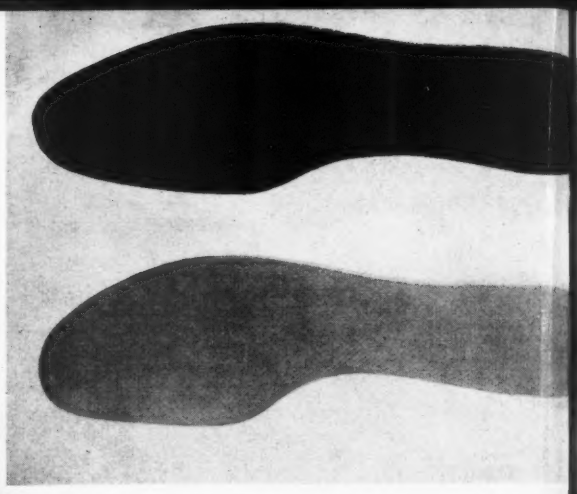


Fig. 6 (right).—Upper side of mechanism.

PLASTICS
IN THE SERVICE OF MAN

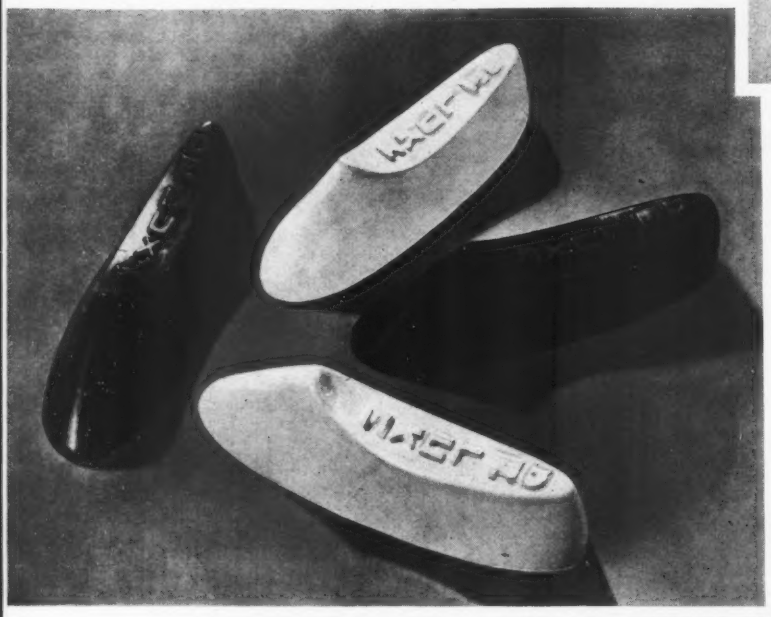
A pictorial review of high-quality units moulded or otherwise fabricated in Great Britain . . .

38. Boots and Shoes



(Above) Insoles for Army boots, made from polyvinylidene copolymer and woven by Fothergill and Harvey, Ltd. The die producing these insoles was made by British Industrial Plastics (Tools), Ltd. The top sole has seven layers and is used for the G.S. boot. Below is the five layer insole for the Mukluk boot. Both are worn by British troops in Korea in boots manufactured by E. A. Chamberlain, Ltd.

(Left) Fillers, vacuum formed by Hunt Partners, Ltd., of Clapton, from Celastoid sheet made by British Celanese, Ltd.

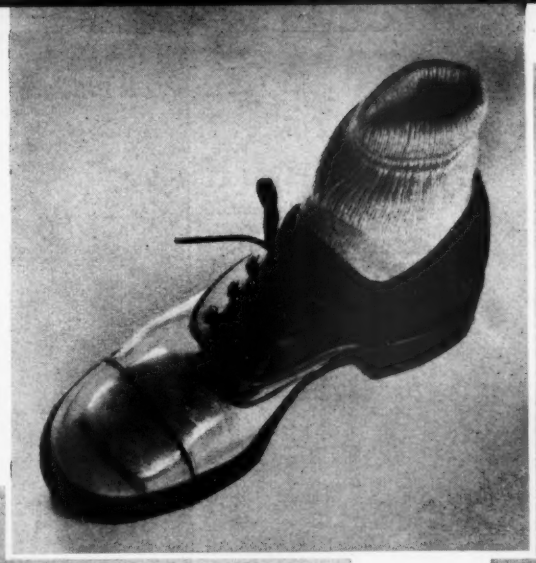


(Right) Men's sandal manufactured entirely from Nuberlite, a new product which can be moulded in various colours. The material is distributed by Avon Footwear Sales Ltd.

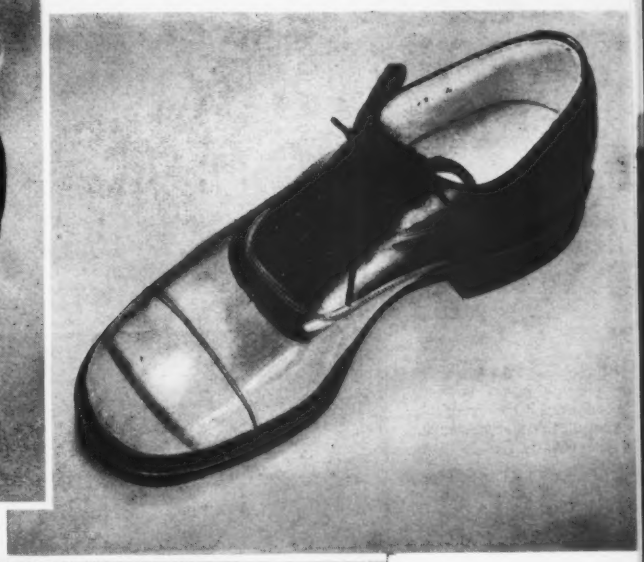
(Above) Welded overshoes manufactured from p.v.c. The overshoe is welded to a sole and the complete unit can be folded and carried in a handbag. Manufactured by W. H. Auten and Co.

(Left) Man's brogue. The upper and sole are of Nuberlite, distributed by Avon Footwear Sales Ltd., and the heel is of a rubber compound. The use of Nuberlite for shoe uppers is still in the experimental stage.

(Right) Fitting shoe, with sock and plastics foot inserted, manufactured by A. & W. Arnold Ltd., employing transparent p.v.c.



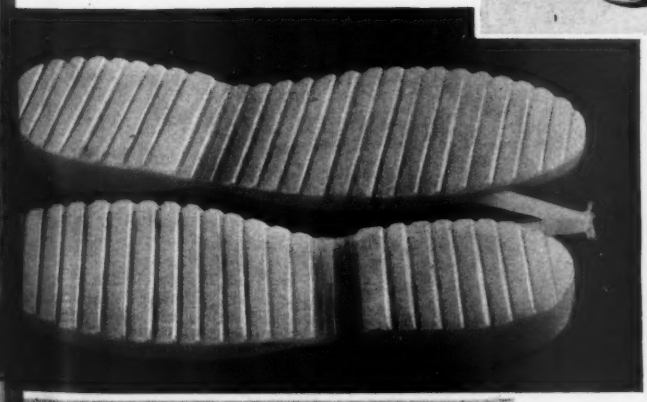
(Below) Ladies' rough-glove casual shoe manufactured by Barfield and Richardson, Ltd., fitted with microcellular resin / rubber soling Nuberlite, distributed by Avon Footwear Sales, Ltd.



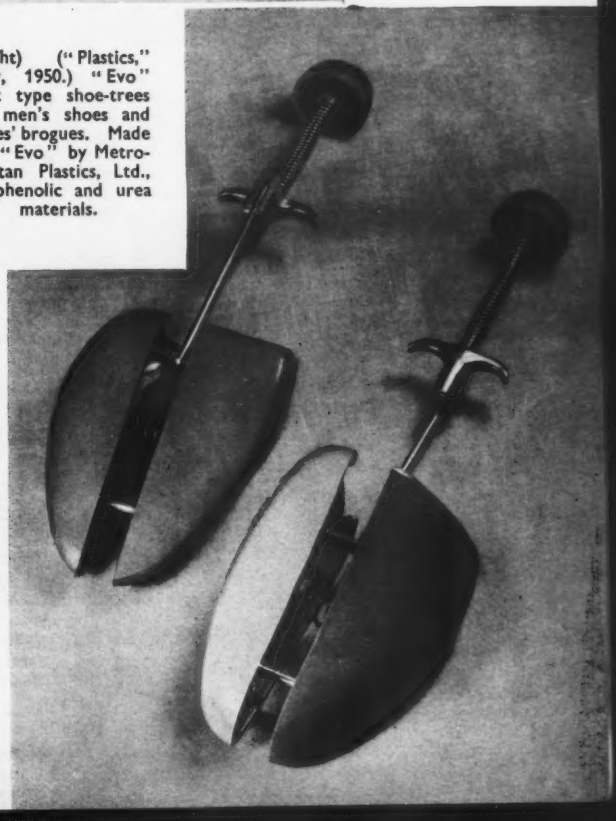
(Above) Shoe, as shown at top left, with foot extracted. The transparent p.v.c. ensures accurate fitting.

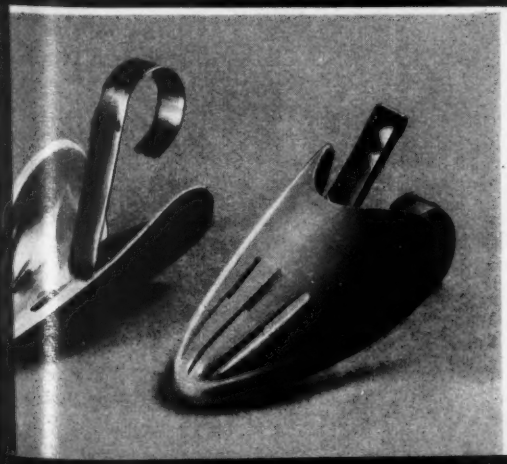
(Left) Miners' boot. Toe-cap and counter are of p.v.c., manufactured by B.X. Plastics Ltd.

(Below) Injection moulded from polythene, these sandals' platforms are experimental patented prototypes.



(Right) ("Plastics," May, 1950.) "Evo" split type shoe-trees for men's shoes and ladies' brogues. Made for "Evo" by Metropolitan Plastics, Ltd., in phenolic and urea materials.

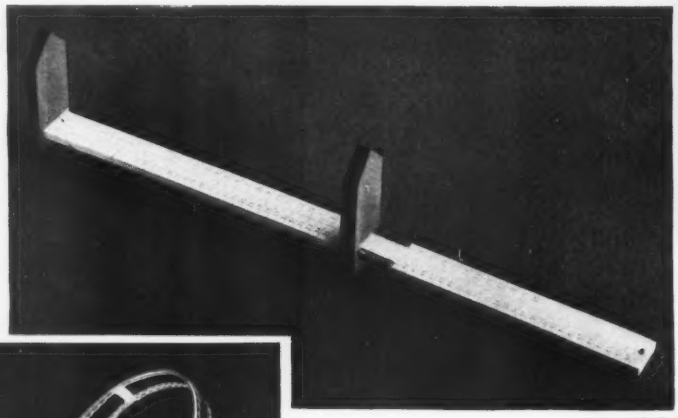




(Left) ("Plastics," May 1950). Shoe trees for ladies' heel-less shoes. Moulded in attractive colours in urea, by Metropolitan Plastics Ltd., for "Evo."

(Right) Shoe display stand fabricated from acrylic material supplied by Imperial Chemical Industries, Ltd.; manufactured by Thermoplastics, Ltd., Dunstable.

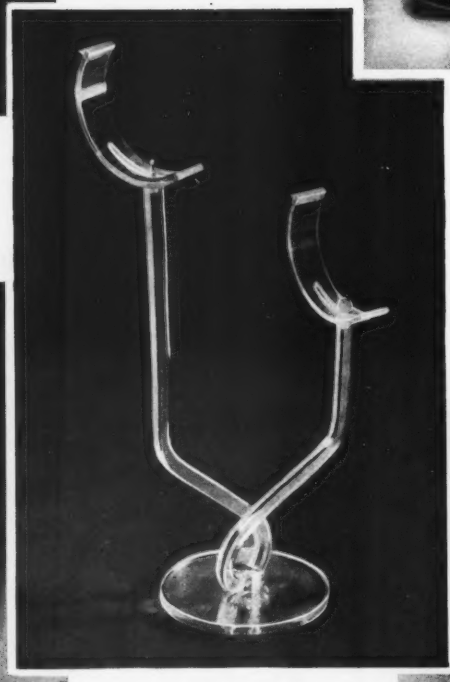
(Above) Sandal style shoe employing p.v.c. uppers, calendered to give a crocodile skin appearance. Marketed by Dolcis, Ltd.



(Left) Foot measuring gauge, fabricated from extruded p.v.c. by Blundells Rules, Ltd., for Stephen Lucking, Ltd., Chester.

(Above) Summer shoe fabricated in white linen and transparent p.v.c. manufactured by Bakelite, Ltd. The latter has been stitched to give a decorative effect.

(Above) Woman's slipper, in Grecian style the upper of which is in black p.v.c. Distributed by Dolcis, Ltd.

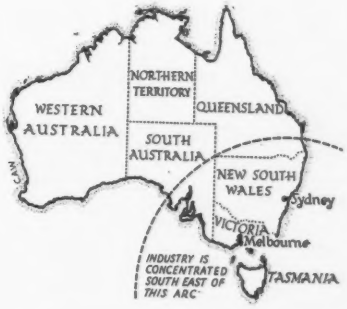


(Above) Shoe display stand fabricated from acrylic material made by Harris and Sheldon, Ltd.

(Below) High quality shoe, simulating leather manufactured by Mellowhide Products, Ltd. in p.v.c. material. The shoe is distributed by Dolcis, Ltd.

(Left) Shoe filler, blown from Celastoid which is manufactured by British Celanese, Ltd.

The Plastics Industry in Australia



We publish herewith comments on a new publication, "The Structure and Capacity of Australian Manufacturing Industries." Copies of the survey, price £3, may be obtained from booksellers, and enquiries should be addressed to the Senior Representative, Department of National Development, Australia House, Strand, London, W.C.2.

IN early March, 1952, the Australian Government imposed certain severe import restrictions, as a result of which many companies in Britain have experienced a serious reduction in sales. The British plastics industry was amongst those to be markedly affected, and although there has been some slight relaxation in Australian policy in recent months, the future trade prospects for Britain in that country must be a matter for careful consideration.

Australian industry has expanded greatly since 1939 and the limitation of imports may well have consolidated this expansion. Goods that were formerly imported are now to a certain extent being manufactured by Australian companies and when the relaxations have been entirely removed it may be found that Australia is capable of satisfying a greater proportion of its own requirements than was formerly the case.

It is difficult to determine accurately what we may expect to find two or three years hence but a new publication "The Structure and Capacity of Australian Manufacturing Industries" throws considerable light upon the position as it is today. The survey has been prepared by the Department of National Development, and sets out to identify the major Australian industries, reviewing the structure of each. The two sections devoted to the chemical and plastics industries gave facts and figures which may be of considerable value in assessing Australia as a market in future years.

Reading the survey of the plastics industry one is impressed with the feeling that an organized industry has emerged from its pre-war chrysalis. It is clear that on the moulding side at least the Australians have appreciated its importance as a basic fabricating industry.

In 1948/49, 4,780 people were employed in the manufacture of plastics productions (excluding plastics insulated cables); of these 2,020 were working for the ten firms employing more than 100 people. With a population of 8½ million, this suggests that per capita .05% of the people are working in the industry. The total number employed in plastics production in Britain is estimated very roughly at 80,000 people. With our population of 50 million a comparative per capita figure seems to be approximately 1.6%.

The pattern of the Australian industry is somewhat different to ours, in that compression moulding constitutes by far the largest section—65 companies specialize in this field as compared with 13 who do only injection moulding. The proportion of companies fabricating only, including forming, blowing and drawing, is also high, 44. The total number of companies is 191, and practically all have their own tool rooms and make their own dies. Current figures indicate that the industry today employs over 5,000 people, largely concentrated in Sydney and Melbourne.

On the raw materials side, the four largest companies are as follows:—

Imperial Chemical Industries of Australia and New Zealand Ltd., producing, inter alia, caustic soda, calcium carbide, formaldehyde, polyvinyl chloride.

Monsanto Chemicals (Australia) Ltd., producing phenol formaldehyde. The production of polystyrene from imported monomer is also projected.

Colonial Sugar Refining Co. Ltd., producing ethyl acetate, acetone and butyl acetate. Plant is also in process of erection for the manufacture of cellulose acetate moulding powder.

Timbrol Ltd., producing xylenes, cresols, xylenols and phenol.

Elliotts and Australian Drugs Pty. Ltd., which through an associated company produces urea formaldehyde and melamine moulding powders.

Imports of raw materials, perhaps, indicate future trends. Thermosetting compounds, amounting to 1,021.1 tons in 1948/49, were down to 833.2 tons in 1949/50, in contrast to thermoplastic materials which amounted to 1,790.9 tons in 1948/49, as against 2,727.8 tons in 1949/50, an increase of 50%. The import of casein and other protein types fell from 13.8 tons to 3.4, a drop of 75%. In aggregate, materials imports rose in 1949/50 by approximately 26%.

Of the thermosetting materials imported for 1949/50, 200 tons comprised phenol, 26 tons alkyds, 579 tons urea and melamine, and 28 tons of miscellaneous resins, including lignins and estergum resins. In the thermoplastic field, alkyds accounted for 68 tons, vinyl resins 762 and polystyrene for 1,060 tons.

On the manufacturing side, the survey yielded some interesting figures. For example, production in 1949/50 was valued under various headings as follows: bottle caps and closures £17,200, buttons £6,370, electrical units £89,400, machines parts £230,000, radio cabinets £139,000, toys £611,000. The total value and output of all plastics articles produced in Australia is estimated to be about ten million pounds a year. It should be noted that all the foregoing figures are quoted in Australian pounds (conversion rate, approximately £1 Australian, 16s. sterling).

Hair combs are not amongst the commodities listed as being manufactured in quantity by the Australian industry. The Australian market has, until recently, been mainly supplied by imports; it is estimated that the value of this section of the total market may be as high as £130,000 per year, and yet the survey reports that some Australian manufacturers have suffered losses in attempting to sell in competition with imported goods.

The survey would have been of greater assistance had it paid more attention to plant capacity and the number of various types at present in use by the Australian plastics industry. Again, the reader is left to assume that the production of plastics materials, including moulding powders, is the difference between import figures for 1949/50 and the estimated figures of probable consumption for the years 1951/52. If available, it would have been more advantageous to have given production figures on the raw materials side. Despite these omissions, however, the survey contributes greatly to our knowledge of the Australian plastics industry.

An Achievement in Transfer Moulding

Ferranti Meter Case-backs Moulded in Two-impression Tool

AN important development in the technique of transfer moulding has been made at Ferranti Ltd., Lancs. In the past, all Ferranti meters have had metal case-backs but it was recently decided to mould the back as well as the front of the case of their new FM Meter in black phenolic material.*

The transfer-moulding method is not commonly used in this country and it was especially new to the Ferranti technicians. They adopted this method in preference to the compression method, primarily because the larger number of moulding pins (and particularly the side coring-pins) would suffer by bending if the compression method was used. They also knew that the "cure-time" would be shorter by the new method, and that less flashing would be left on the product.

By moulding the back of the case five main advantages are gained:—

1. The electrical insulation is improved.
2. No paint or other finish is required.
3. The product is rust and corrosion proof.
4. It is lighter in weight.
5. Four drilled holes are the only machining required.

** When production started, the only thermosetting powder which had been found to mould satisfactorily was Bakelite X20/5TX. A suitable alternative moulding powder has also been obtained with the co-operation of Resinous Chemicals Ltd.*

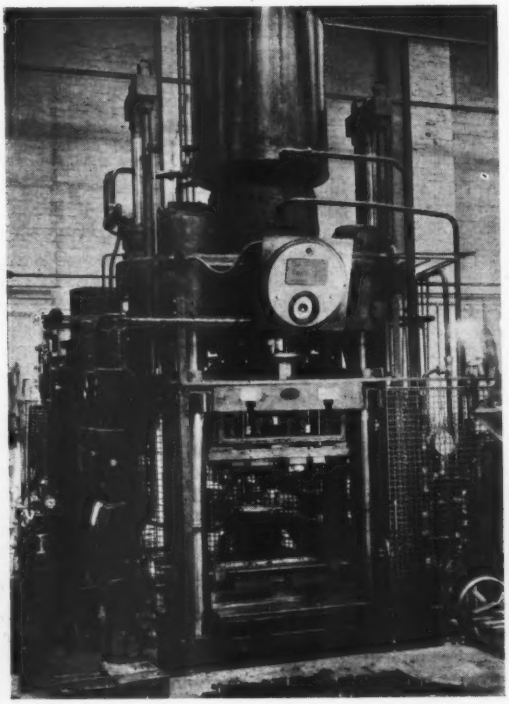
Design Considerations

It was also decided that two case-backs should be moulded at one time. Two impressions were the maximum number which allowed the operator free access to the tool with identical gating of each mould. The moulding of more than one case-back at a time did, however, present a disadvantage: owing to the necessity for extracting the coring-pins for the terminal block outwards, it was essential to have this block which is the thickest part of the moulding, at the opposite end from the powder feed from the central "pot." A chance also had to be taken on the powder flowing freely under these adverse conditions. On the trials of the tool, two successful mouldings were made on the second closure of the press—a gratifying climax to many months of planning and endeavour.

Another point to be decided was the tonnage of the press, which was fixed at 50 tons for "transfer," and 250 tons to hold the tool closed during moulding. The coring-pins for the terminal block are hydraulically operated. The press is completely automatic in its various hydraulic movements after a manual closure at the commencement of the moulding cycle.

Having decided on transfer-moulding, a suitable size of tablet had to be determined and a tableting machine was required. The largest machine available at the time could make a tablet of 3 in. maximum diameter so the "pot" in the tool was designed to take tablets of this size. Tablets were preferred to loose powder because individual weighing of each charge was eliminated, and the tablets more easily handled in the high-frequency set. Moreover, powder gives more trouble than tablets by flashing between the pressure "pot" and plunger, causing seizure and cleaning problems.

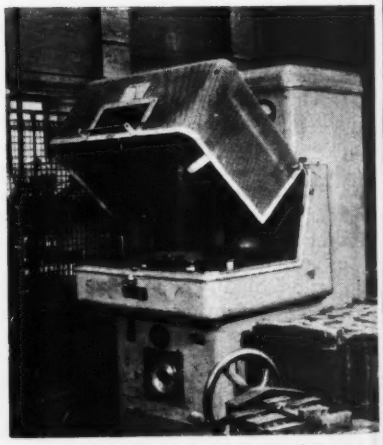
It was then decided that none of the inserts should be moulded directly into the case-back. In taking this decision Ferranti were following their own accepted practice, since they prefer whenever possible to knock inserts into the hot moulding after removing it from the tool. "Idle" press time is thus cut to a minimum, and the tool does not get damaged by loose or incorrectly loaded inserts. A trial moulding of an insert-carrying boss was made to determine the interference fit necessary between the diameter of the insert and the moulded hole in which it was to be driven. By making this preliminary test it was possible to guarantee that the inserts did not come loose by being too small or cause cracked bosses in the finished mouldings by being too large.

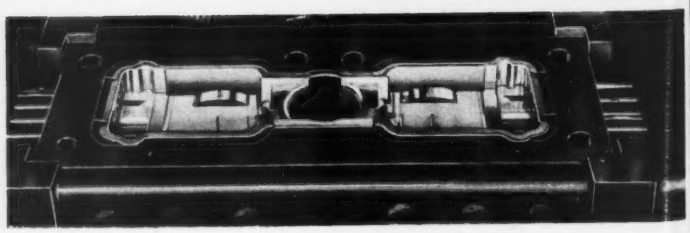


(Left) Daniels 250-50 ton transfer moulding press, complete with tools.

(Right) Ferranti Wild-Barfield h.f. preheater shown at the side of the moulding press.

(Below) Close-up of bottom tools, showing position of side pins.





The size and shape of the feeder gates from the " pot " to the tools was decided by judgment from the meagre information available. An attempt was made to err on the small side for safety, however, and in fact the gates did require opening out slightly.

Moulding Operation

The sequence of operations during the moulding process is briefly as follows:— After loading the " thimbles " on the coring-pins in the tool the next move is to place five tablets of moulding powder in the cylindrical " pot " in the bottom tool between the two impressions. These tablets are first pre-heated in the Ferranti HF set for about 33 seconds to attain a temperature of approximately 180° F. The operator then lowers the top tool onto the bottom tool and closure is maintained at 250 tons pressure. This movement starts an automatic cycle as follows:—

1. The coring-pins carrying the " thimbles " move inwards.
2. The charge of moulding powder is " transferred " from the " pot " to the two impressions by a pressure of 50 tons.
3. The hydraulic pressures are maintained for one minute, during which time the two mouldings cure.
4. The coring-pins are withdrawn hydraulically, leaving the "thimbles" in the mouldings.
5. The transfer-ram returns.
6. The press opens and the mouldings are automatically stripped from the top tool.

The " pot " and the tools are maintained at a constant temperature of about 350° F. by electric heating. The plasticized tablet is further heated by the friction of passing through the narrow gates into the tools so that polymerization, or curing, is partially completed in passing those points, giving minimum cure time.

The " thimbles " are removed from the stripped moulding by pressing in a suitable fixture and five inserts are knocked into each case-back whilst it is still warm. These operations are carried out on the bench by a female operator, whose cycle of duties is completed when she has placed a shrinkage block in each moulding to prevent distortion during cooling.

There is very little flash to be trimmed from the mouldings. All the flashes in the holes at the terminal block end are cleared in the operation whilst the four handle-holes are drilled in a second one by a machine designed at this factory. After the spraying of a white band inside the case-back, the latter is ready for feeding to the assembly conveyor.

Stripping two mouldings from the top punch after ejecting.

Closely associated with the development of the project from the birth of the first drawings on the drawing board to the final product on production lines were Mr. J. S. Ashbey, Chief Tool Designer of Ferranti's and Mr. J. Holt, Foreman of the Meter Moulding Shop.

New Range of Polyester Resins

WE have received from Bakelite, Ltd., some information dealing with their series of polyester resins. In view of the attention which has been focused on this range of materials, we are pleased to publish the following technical data which in this instance relates to the Bakelite products.

Polyester resins, because of their ability to cure exothermically by additional polymerization, can be employed for low-pressure laminating and moulding, and are particularly valuable for the production of large structures. Satisfactory mouldings may be prepared from ceramics, plaster of paris, rubber, steel, lead, and coated cuprous alloys. Where metals are employed a wax parting agent can be used.

Pot Life and Curing Rate

Pot life and cure rate are controlled by the types and percentages of catalysts added. Influencing factors are temperature, normal batch-to-batch variations, resin age, contamination, and ultra violet ray. When preparing resin mixtures, the catalyst should be dissolved in the minimum amount of styrene before mixing well with the resin. Resin viscosity can be lowered by dilution with styrene, but too great an increase in the styrene content will have adverse influence on the amount of shrinkage during cure. The resins are photo-sensitive and will gell in a few hours in the absence of any catalyst if exposed to bright sunlight, and this factor can be used when preparing castings and mouldings.

Fillers

Both cost and the danger of cracking can be reduced by the addition of fillers such as finely ground silicates, glass fibre, cotton linters, etc. The catalyst concentration should be the same for filled and unfilled resins. Benzoyl peroxide can be recommended (0.5%-1.5% for most work depending on curing temperatures).

Casting and Embedding

Casting of filled and unfilled resins can be carried out from room temperatures upwards depending on catalyst, thickness of sections of casting, quantity of filler. For thick sections it is recommended that the temperature should not be allowed to exceed 40° C. until the resin is gelled, after which it may be allowed to rise to 100° C. Uneven temperatures across the surface of the casting should be avoided to prevent cracks consequent upon uneven shrinkage.

Delicate components such as miniaturized radio circuits can be protected by the embedding technique. The thickness of the resin should be limited to a maximum of ¼ in. to avoid stress and consequent cracking. Cure should be as slow as possible and at room temperature and the article to be cured must be completely wetted by the resin.

Range of Resins

Unsaturated alkyd resins dissolved in styrene, the information issued by Bakelite Ltd. numbers the following: S.R.17431, S.R.17438, S.R.17740.

S.R.17431 is a general-purpose resin for the production of glass reinforced plastics requiring good electrical and mechanical properties.

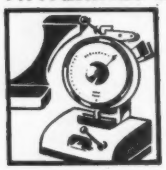
S.R.17438 is very flexible and can be used for applications requiring toughness and flexibility. It can also be used to modify other Bakelite polyester resins to impart resistance and strength in structural laminates and mouldings.

S.R.17440 can be employed for the production of glass reinforced plastics, but is also suitable for casting purposes. In this application it has less tendency to crack during curing than S.R.17431.

The information issued by Bakelite also contains details of catalyst specified as being applicable to these resins.

World's Industry Employs Plastics

MATERIALS and TESTING



Stress optical investigations. — A. Kuske deals with the evaluation of plane stress optical tests on plates and discs using the two-layer method. (*Forschung-Ingenieurwesen*, 1952, Vol. 18, pp. 113-126.)

Determining the molecular weight of high polymers.—A new constant for the average molecular size, easily determined by the relationship between viscosity and concentration has been introduced. A relationship with the methods applied in the United States is shown. (*Kunststoffe/Kunststoff Praxis*, 1953, Vol. 43, pp. 36, 37, Jan.)

Tensile strength of plastic joints.—Reports on tensile tests on light-metal joints glued with Araldit to investigate whether the fracture load through tensile-shear stresses depends on the geometrical form of the joint. (*Schweizer Archiv f. angew. Wissenschaft & Technik*, 1953, Vol. 19, pp. 33-39, Feb.)

Ageing tests on bonded plastics.—Urea-formaldehyde plastics of various origins and various viscosities and three types of plasticizers were exposed to different weather conditions for varying periods, including accelerated ageing tests. (*N.L.L. Report* (M 1883), Holland, July 1, 1952.)

Specific heat of plastics.—T. H. Gast discusses the possibilities of measuring the specific heat of plastics. P.V.C. samples were heated in a water calorimeter and in a steam calorimeter. (*Kunststoffe*, 1953, Vol. 43, pp. 15-18, Jan.)

Polyethylene.—J. L. Huscher investigated the corrosion resistance of polyethylene. (*Chem. Engineering*, New York, 1952, Vol. 59, p. 260, Oct.)

Reinforced polyester plastics.—R. B. Seymour and R. H. Steiner investigated the corrosion properties of polyester plastics. (*Chem. Engineering*, 1952, Vol. 59, pp. 278-286, No. 12.)

Influence of molecular weight on properties of polystyrene.—Thin films free from internal stresses made from polystyrene and its compounds were tested. For the first time the interrelationship between the various factors has been revealed. (*Kunststoffe*, 1953/Jan./9.)

Migration of plasticizers.—G. Beck and A. Rosenberg discuss the migration of plasticizers on practical examples and deal with polymer-gelatine substances and protecting layers. Methods used hitherto are discussed, and a new test method is suggested. (*Kunststoffe*, 1952/Dec./101.)

INDUSTRIAL APPLICATIONS

Plastic models.—Duplication of plastic models is coming into common use as a production aid in setting up assembly jigs and fixtures; fibre-glass combined with polyester resins is used. (*Tooling and Production*, 1953, Vol. 18, pp. 60, 61, 68, 86, Jan.)

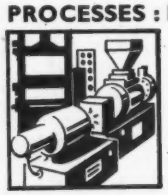
New sand core bonding resin.—A new phenolic liquid resin, soluble in water, has been developed. After curing in ovens or dielectric dryers, the resulting cores have good water resistance. (*Materials and Methods*, 1953, Vol. 37, p. 140, Jan.) Producer: Durez Plastics and Chemicals Inc., North Tonawanda, N.Y.

Metal cutting, strain free.—In a new method for cutting soft metals such as brass a plastic thread of Saran is run through a bath of nitric acid and over the metal to be cut. (*Review of Scientific Instruments*, Vol. 21, 1952, pp. 881-883, Oct.)

Wire insulation by lacquering.—In this field high polymers are increasingly used while condensation products lose ground. In this general survey the specific properties of the different plastics are discussed. (*Kunststoffe*, Vol. 43, 1953, pp. 19-21, Jan.)

Plastics in the chemical plant were reviewed by G. H. Black; he dealt with properties, manufacture, applications and economy. (*Chemistry and Industry*, 1952, pp. 727-734, No. 30.)

PROCESSES : MACHINERY



Vacuum metalization. — Vacuum vapour platings of metal and plastics with metal coatings are described giving general techniques and possible applications. (*Products Finishing*, 1953/Vol. 17/Jan./30.)

Machining of plastics with carbide tools.—Useful notes for the production engineer giving information on the grinding of sintered carbide tools for machining plastics. (*Kunststoffe/Kunststoff Praxis*, 1953, Vol. 43, pp. 33-36, Jan.)

Plastic moulding dies.—In a survey on present-day tool steels T. M. Barclay also discusses the steel qualities recommended for this purpose. (*The Toolmaker and Precision Engineer*, 1953, pp. 4-12, March.)

COATINGS and ADHESIVES

Reduction of curing times for synthetic resin glues.—This is possible by the use of electric bandheaters. Suggestions for the practical arrangement, data on current consumption, voltage, heating time, etc. (*Kunststoffe*, 1953/Jan./37.)

Wood to steel joining.—An increase up to 150% in television cabinet production was possible by joining wood to steel by a rubber resin composition. (*Materials and Methods*, 1953/Jan./82.)

Heatseal adhesives.—H. Wittcoff and D. Peerman investigated plastic adhesives used for packaging purposes. (*Modern Packaging*, 1952, Vol. 26, pp. 135-140, No. 3, Nov.)

MISCELLANEOUS USES

Bleach container.—The report describes a storage drum, made of polyester resin reinforced with glass fibre. Metal fasteners were eliminated by the use of plastic closures. This container has been accepted by the U.S. Armed Services and their former specification for bleach containers amended accordingly. (U.S. Army Chemical Centre, Maryland. Engineering Division report TCIR.626 PB 103103.)

Plastic car bodies.—General Motors' preview of a number of new sports cars with glass fibre-reinforced plastic bodies, considered as a great advance in plastics technology. (*Automotive Industries*, 1953, Vol. 108, pp. 52-53, Feb. 1.)

Low-pressure laminates.—G. C. Hulbert describes recent developments in plastics technology. New developments, such as a yacht, are described. (*Research*, 1953, Vol. 6, pp. 54-60, Feb.)

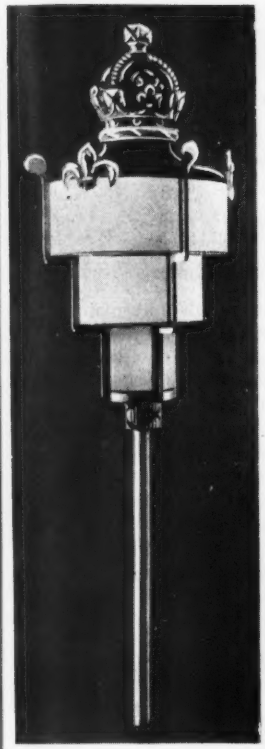
Plastic master maps are a part of a scheme to make a relatively inexpensive aerial survey of larger districts. (*Electrical World*, 1953, p. 22, Jan. 5.)

Reinforced glass-fibre plastics for aircraft use were analysed by N. C. Parrish. They have excellent shock absorption properties, are flexible and complex-curved surfaces can be produced, etc. (*Automotive Industries*, 1953, Vol. 108, pp. 38-39, March 1.)

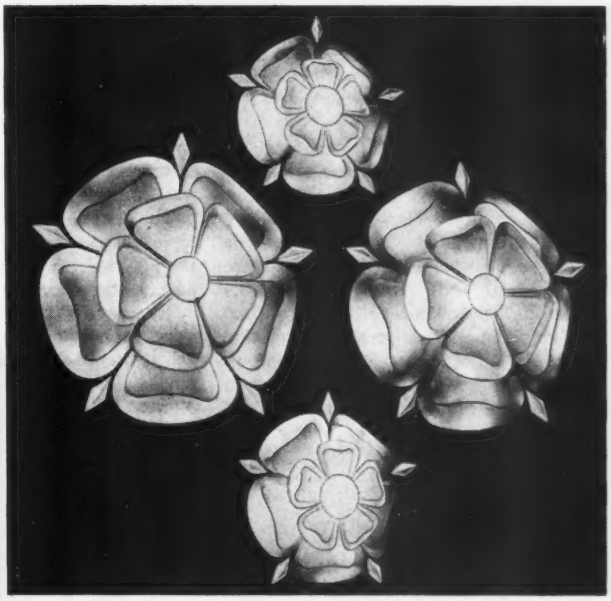
Lightweight foamed plastics are used to form radomes and for strengthening an aileron section of the Lockheed F-94C Starfire. (*Automotive Industries*, 1953, Vol. 108, pp. 41, 84, March 1.)

Illuminated Decorations for the Coronation

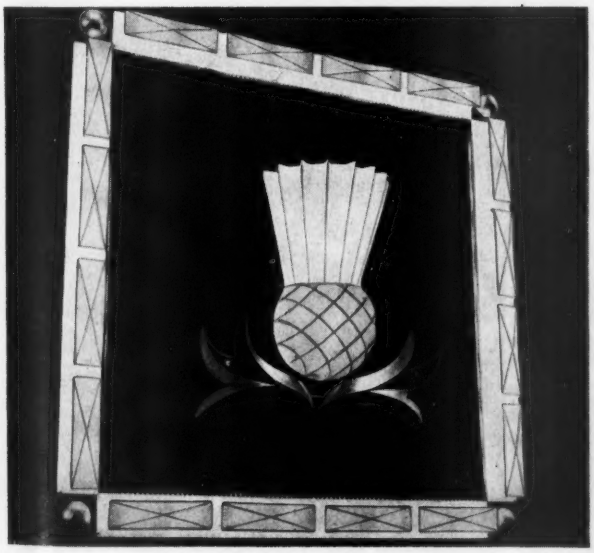
In producing special street-lighting lanterns and other illuminating devices for Coronation decorations of streets and buildings The General Electric Co., Ltd., are employing plastics: For the laminated paper lanterns (left and below) translucent coloured cellulose acetate sheeting has been used; for the other emblems and lanterns the Chrysaline technique of spraying a plastic skin has been employed.



(Above) Post-top lantern with laminated paper crown; stepped sides are red, white and blue acetate. (Right) Laminated paper lantern has translucent acetate panels printed with Lion and Royal Cypher.



(Above) Four Tudor Roses and (left) 2 ft. Fleur-de-Lys device, both in Chrysaline.



(Above) Thistle framed by four illuminated border units, all in Chrysaline. (Right) Two post-top lanterns in Chrysaline, with coloured flock-sprayed panels.

Ekco Moulds Polythene Bottles

E. K. Cole. Ltd., Plastics Division, has now entered the field of manufacture of polythene bottles, one of the great potential markets for plastics. The methods of production are unconventional and ingenious

THESE new flexible packagings for powder or liquid combine an attractive appearance with a quite remarkable degree of utility. They are available in two and four fluid ounce sizes with a wide range of colours and they are supplied ready to fill, with the user's label printed directly on the bottle.

The contents are ejected through the nozzle by a gentle finger-and-thumb pressure on the sides of the bottle and three types of nozzle are produced to suit differing forms of content, such as cream, liquid, scents, lotions, etc. These include a side spray as well as a direct spray.

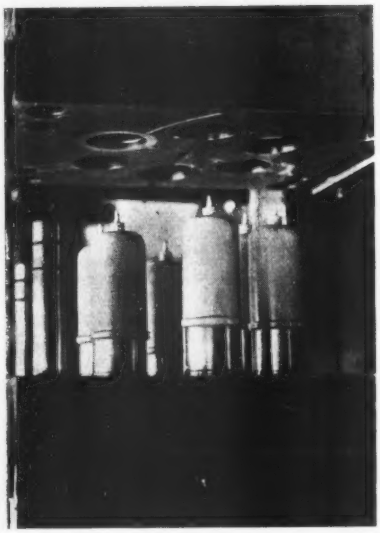
The Ekco bottle comprises four separate injection mouldings, these are: (1) the cap, (2) the nozzle, (3) the body, and (4) the base.

The nozzles are edge-shot in a multi-impression two-plate tool and a similar procedure is employed for moulding the bases. The caps are moulded in a multi-impression three-plate tool using restricted gates while the body is moulded in a similar tool which incorporates a diaphragm-gate feeding into the bottle necks. A specially designed pneumatic machine is used for automatically removing the diaphragm-gates from the bodies.

The printing of the bodies is carried out (where required) before fitting the bases, each body being loaded on to a mandrel which forms part of the specially designed printing machine employed. This mandrel is attached to an endless belt which rolls it over a heated platen on which the printing matter is formed in relief as in the case of a normal printer's block. Thus a body is placed on the mandrel and is rolled across the heated platen to receive an impression therefrom. Colour is provided by interposing a colour-carrying foil between the platen and each body that rolls across it, the colour foil being automatically roll-fed.

Each body is automatically ejected from its mandrel by air pressure as soon as it has passed over the printing platen. It is then loaded into a welding machine in which pressure and heat permanently seal the base and body together. The sealing of the bases is then tested on another rig for leakage under an air pressure of 15 lb./sq. in.

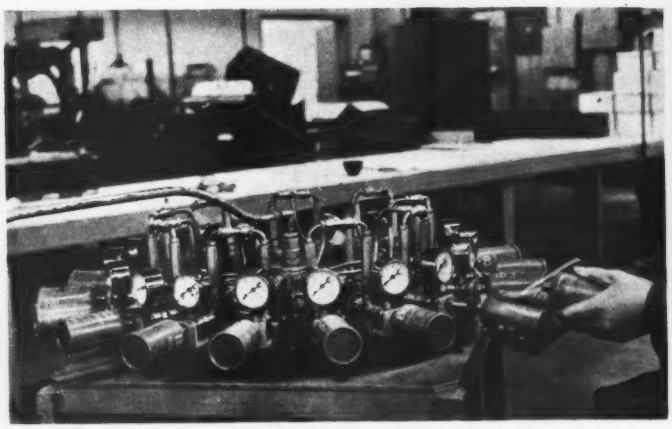
The nozzle is fitted simply by pressing it into the neck of the body, and this can be done without special equipment after the bottle has been filled. The cap seals the bottle finally, being simply pushed on. The nozzle is so designed that, if required, an extruded polythene tube can be pressed into it, the tube extending to the bottom of the bottle when the nozzle is fitted.



(Above) Bodies are moulded in a multi-impression tool incorporating a diaphragm-gate feed into the necks.

(Right) A specially-designed machine, operating pneumatically, removes the diaphragm-gates from the polythene bodies.

(Below) Testing bottles for leakage under air pressure of 15 lb./sq. in.



Basic Principles of Injection Moulding

By C. E. BEYER and R. B. DAHL*

This paper won the First Prize awarded in the 1952 prize paper contest held by the Society of Plastics Engineers. It is reprinted here, by permission of the Society, from the S.P.E. Journal, February, 1953.

The controls available to the injection moulding machine operator can be separated into two groups. Since the quality of the moulding is primarily determined by the pressure in the mould and the temperature of the plastic material at the time the gate freezes, the controls that directly affect this sealing pressure and temperature are classified as the primary controls. The other controls that either have no effect on the sealing pressure and temperature, or are predetermined by the primary controls, are classified as secondary controls. The effect of these controls is discussed.

IN the past 20 years shot size of injection moulding machines has grown from a few ounces to the 300- and 400-oz. machines in use today, with even larger capacities being planned. Even with this tremendous growth in the size it has only been in the past few years that much work has been done on obtaining an understanding of the basic principles of the injection moulding process. The operators of the giant moulding machines now in use have the same controls as the operators of machines in the past. The moulder of today knows that to produce a moulding of the highest quality he must have the correct relationship between the:

1. Injection temperature.
2. Injection pressure.
3. Plunger forward time.
4. Mould closed time.
5. Mould temperature.
6. Mould open time.
7. Clamping force.
8. Plunger speed.

Most of these controls are so interrelated that a simple adjustment is not possible. For example, if the injection temperature were increased the mould may start to flash, so that the injection pressure may have to be reduced. At this lower pressure the plastic may fill the mould slower so that the plunger forward time may have to increase. This paper is an attempt to describe the relationship between the various controls available to the injection moulding machine operator.

These controls can be separated into two classifications, one a set of primary controls which directly control the quality of the moulding, and a set of secondary controls which either do not directly affect the quality of the moulding or are predetermined by the settings of the primary controls, as shown in Table I.

Table I

Primary Controls.	Secondary Controls.
Injection temperature	Mould closed time
Injection pressure	Mould open time
Plunger forward time	Clamping force
Mould temperature	Plunger speed

A quick summary of the injection moulding cycle is sufficient to show how each of these controls was classified.

* The Dow Chemical Company, U.S.A.

The plastic is forced into the mould by the pressure of the injection ram at the temperature of the molten plastic, not necessarily that of the temperature controller settings. The pressure in the mould has been measured to be anywhere between 25 and 50% of the injection pressure. After the material has completely filled the mould there is a short packing period where the injection ram holds the pressure in the mould as the plastic cools. The rate of cooling depends upon the temperature difference between the plastic and the mould. The plunger then returns to its starting position. If the material in the small restriction at the entrance of the mould, commonly called the gate, has not cooled sufficiently to withstand the pressure in the mould, there will be some discharge of plastic from the mould. This will lower the pressure in the mould to a pressure that the material in the gate can withstand. Thus the mould is now separated from the rest of the machine and the quality of the moulding has now been established. The rest of the cycle consists of letting the plastic cool so that it may be removed from the mould. Thus the primary controls are those which determine the pressure and temperature at which the gate seals, and consequently, the quality of the moulding. For the purpose of this discussion, a good moulding is defined as a moulding free from sinks, bubbles, scoring, cracks, etc., which primarily depend upon having the correct amount of plastic in the mould. There are other defects that may appear in the mouldings, and some of these are discussed.

Discussion

The mould used to investigate the effects of the control variables on the mould pressure and plastic temperature was the same box mould described by Gilmore and Spencer.[1] The mould is a conventional type with a box-shaped cavity 4 x 4 in. square, with a 2.500 in. draw. The gate dimensions are 0.035 x 0.375 in. with no land length. The wall thickness is 0.170 in. with a resultant shot size of 6 oz. in polystyrene. The pressure pick-up was mounted in the cavity insert. The pressure measuring device works on the mutual inductance principle and is described in detail by Towsley.[2] The cooling characteristics of this mould are known, so that the average plastic temperature can be calculated at any time.

While the material is cooling in the mould, the mould pressure/plastic temperature relationship can be determined from the equation of state of the material. For polystyrene the equation of state is

$$(P-\pi)\ (V-\gamma)=RT^{(3)}$$

where P=Pressure in mould,
V=Specific volume,
T=Temperature,
π, γ, and R are constants depending on the material.

For the constant volume situation that exists in the mould this equation when plotted with pressure and temperature as the co-ordinates, as shown in Fig. 1, would give a series of straight lines that would intersect at a temperature of absolute zero and a pressure $-\pi$ p.s.i. with the slope of the line depending on the density of the weight of plastic in the mould cavity.

As the plastic enters the mould the outer portion that touches the mould surface freezes almost instantaneously and as time goes on this layer increases in thickness until the whole moulding is frozen. The gate is usually the smallest

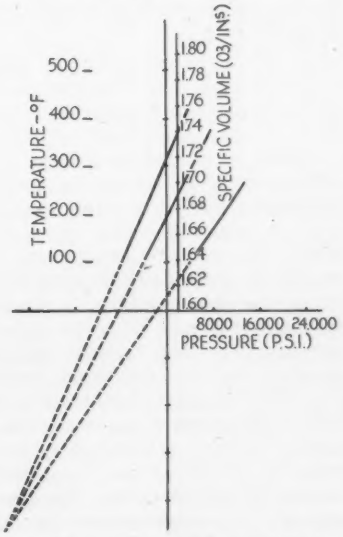


Fig. 1.—Pressure, temperature and density relations for polystyrene.

restriction in the system, so that it will be the first place to freeze. As the material cools, the effective size of the gate keeps decreasing and the size of this orifice will depend upon the average plastic temperature. Thus, if the plastic temperature is lower, the diameter of the molten plastic in the gate will be smaller thus holding a higher pressure in the mould. When this pressure, effective diameter and rate of cooling come to an equilibrium condition so that there is no flow through the gate, the mould is then completely separated from the heating cylinder and the gate can be considered sealed. Below this sealing point the pressure and the plastic temperature will follow a line of constant density given by the equation of state for the material.

The sealing pressures can be determined experimentally from the pressure measurements and the point at which the cooling curve crosses this sealing pressure will give the sealing pressure and temperature required to give that specific weight of moulding. Several of these sealing points were determined by this method. For this mould these sealing points lay along line MN of Fig. 2. In a complicated mould, particularly a very thin-section moulding, the pressure in the mould is not uniform, so that the experimental values of these sealing pressures will depend on the point at which pressure measurements are taken. This was then the sealing line for this particular mould, below which the mould is completely isolated from the machine. The quality of the article is largely determined by the point where the pressure-temperature curve crosses this line. For example, if the sealing temperature was decreased the sealing pressure would be greater, resulting in a heavier moulding. The position of this sealing line will depend largely on the design of the particular mould and the size of the gate.

To explain the effects of the control variables on the article, the pressure and plastic temperature at some point in the mould can be followed on a graph with the same co-ordinates as Fig. 1. The molten plastic is forced into the mould by the injection ram. After the mould has filled, the pressure builds up to some value. This initial temperature and pressure is shown as Point A on Fig. 2. During the packing portion of the cycle the plastic will cool while the injection ram keeps forcing material into the mould to maintain the mould pressure (line AB). At Point B the injection ram releases the pressure and returns to its starting position. If the gate has not frozen there will be an almost instantaneous discharge from the mould dropping the pressure down to the sealing pressure (line BC). Once the gate has sealed the mould pressure and plastic

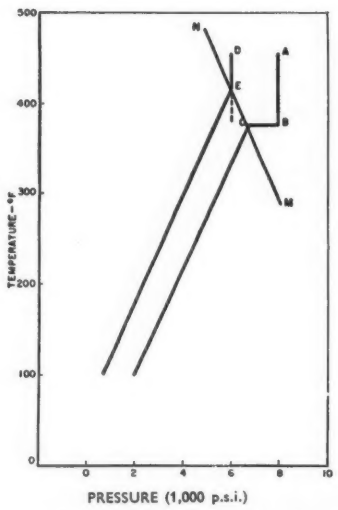


Fig. 2.—Pressure - temperature relations during the injection moulding cycle.

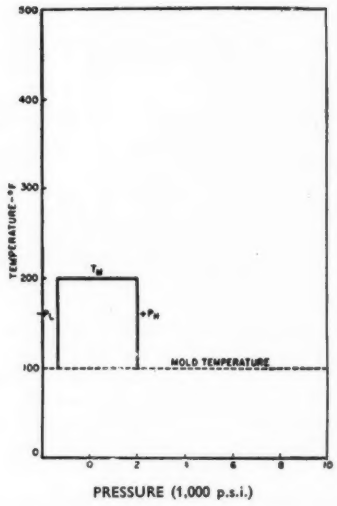


Fig. 3.—Mould opening conditions.

temperature will fall off according to the equation of state. If the injection pressure were lowered (D), so that the gate sealed before the plunger returned, the pressure and temperature would follow the line given by equation (1) and the amount of plunger forward beyond this sealing point will have no effect on the weight of the piece. From this it can be seen that the weight of the moulding is determined by the pressure and temperature at which the gate seals. Thus the major purpose of the primary controls and even such refinements as weight feeding and the ball check nozzle is to give the correct mould pressure and plastic temperature at the time the gate seals.

Secondary Controls

1. Mould Closed Time or Cooling Time

Gilmore[4] has found that, to prevent sticking or scorching of the moulding, the mould pressure must be close to zero when the mould opens. If the moulding has a core there will be a certain minimum value of the mould pressure to allow the moulding to be removed from the core. The mould pressure range where the mould can open is shown $+Ph - Pl$ in Fig. 3. To prevent warpage or distortion of the moulding there is a maximum plastic temperature at which the piece can be removed from the mould (Tm). This temperature will depend largely on the section thickness and the residual strains in the moulding. The cooling time must be adjusted so that the mould pressure is within the boundaries $+Ph$, $-Pl$, Tm and the lower temperature limit, which is the mould temperature below which the plastic cannot cool. The shortest cooling time is that when the pressure, temperature curve crosses one of these boundaries.

2. Mould Open Time

The mould open time is determined by the time taken to open the mould, remove the piece and close the mould again. This is usually kept as short as possible, but at times it may be held open longer to lengthen the cycle so that the plastic will remain in the heating cylinder longer to reach a more uniform temperature.

3. Clamping Force

The clamping force required to prevent the mould from flashing depends upon the injection pressure and the cross-sectional surface area. It is usually set high enough to prevent the mould from parting under pressure and under these conditions has no effect on the quality of the moulding.

4. Plunger Speed

The plunger speed or the rate at which the mould fills does have some effect on the sealing pressure and temperature since it determines how much the plastic cools before the mould is full. The rate of flow is determined by the injection pressure and temperature up to a maximum rate limited by the capacity of the hydraulic pump. In some cases, particularly in heavy section moulding, it may be necessary to reduce the plunger speed to prevent burning of the plastic or other surface blemishes.

Primary Controls

Most of the plastics ordinarily used in the injection moulding machines are very poor conductors of heat. The plastic will not remain in the heating chamber long enough to reach the temperature set on the controllers. Therefore, the plastic temperature as it leaves the nozzle not only depends on the heater settings but also on the rate that the plastic moves through the heating chamber. A method of measuring the plastic temperature and

relating it to the heater settings and the output rate has been described.[5]

The hydraulic system of the moulding machine is set to deliver a predetermined hydraulic pressure to the injection ram. There is a large pressure drop through the granules in front of the ram which will vary with the amount of granular material ahead of the ram and the temperature of the cylinder wall around these granules.[6] There will also be pressure drops through all of the restrictions and channels between the ram and the mould. There will even be a pressure drop through the mould cavity itself. Thus for any given injection pressure the pressure in the mould at any point will depend upon:

1. The position of the ram at the end of its stroke.
2. The temperature of the rear of the heating chamber.
3. The temperature of the plastic, and
4. The pressure drop in the mould.

The primary function of both the injection temperature and pressure is to fill the mould with the required amount of material in a fluid state so as to prevent weld lines or surface marks. If the pressure built up in the mould is below the required pressure to make a good moulding there will be excessive sinks or bubbles regardless of the plunger forward time. Therefore to make a good moulding the pressure in the mould and the plastic temperature when the mould has filled must be greater than the sealing pressure and temperature required to give the proper weight of the moulding. In all practical cases to fill the mould at a reasonable rate with the pressures available the plastic temperature must be much higher than the temperature at which the gate seals. While the plastic is cooling to the sealing temperature more material must be forced into the mould to compensate for the contraction of the plastic in cooling and maintain the pressure in the mould. This packing period can be shown as a vertical line extending below the filling point (Fig. 4). This packing period will extend until the plunger forward timer times out and returns the plunger (AB). Then the mould will discharge down to the pressure that the gate will hold in the mould at that temperature (BC). If the mould pressure at filling was low enough, so that the gate seals before the plunger is returned, any additional plunger forward time beyond the sealing point will have no effect on the moulding (DE). On the other hand, if the gate does not seal, additional plunger forward time (BG) will cause the weight of the moulding to increase. In this case the weight of the box is too large so that the cooling curve does not pass through the boundary limits (+ Ph and Tm) for removing the piece and therefore the pressure in the mould is too high and scoring of the moulding will result. The plunger time necessary to cool the plastic to the proper sealing temperature depends upon the rate of cooling of the plastic, and since the rate of cooling is proportional to the temperature difference between the plastic and mould, the plunger forward time is slightly dependent upon the mould temperature. The greatest effect of mould temperature is in determining the pressure and temperature of the plastic as the mould fills. If this temperature is too low, there will be too much cooling in the sprue and runners and also in the cavity itself, particularly in thinner sections, to produce a good surface on the moulding.

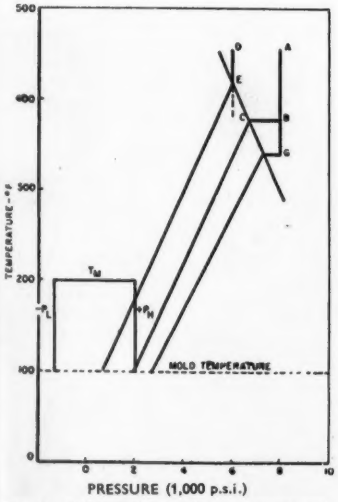


Fig. 4.—Effect of injection pressure and plunger forward on weight of moulding.

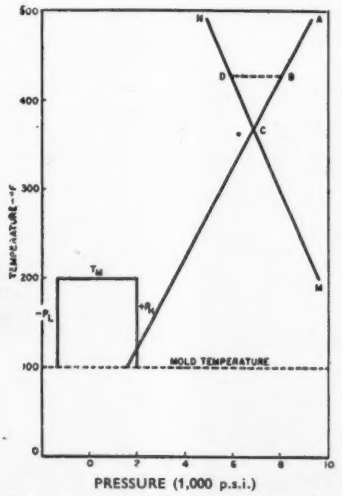


Fig. 5.—Pressure-temperature for weigh feeding.

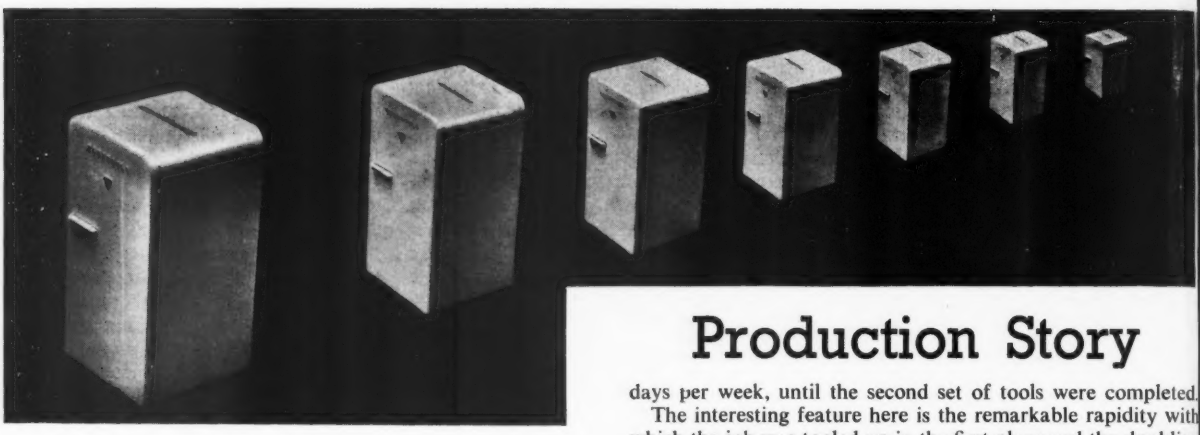
Weigh Feeding

The purpose of weigh feeding and the various types of nozzle and gate valves is to maintain a closer control on the sealing pressure and temperature. In weigh feeding only the correct amount of material is placed in the mould. Because no excess material can enter the mould, the mould pressure cannot be above that required for a good moulding at the time the gate seals. As long as the plunger forward time is sufficient to allow the gate to seal and prevent discharge, all the mouldings will have the same weight. Another advantage is that the injection pressure can be much higher, giving faster filling without getting excessive mould pressure. In weigh feeding all the material goes into the mould during the filling operation; there is no packing period where the plunger forces material into the mould to replace the shrinkage due to cooling. (Fig. 5.) As soon as the mould is filled and the plunger reaches the end of its travel the mould is effectively sealed so that the pressure and temperature will follow the cooling curve given by the equation of state for that weight of material. (AC). As long as the plunger is held forward until the pressure and temperature cross the sealing line a good moulding will result; but if the plunger forward time is too short (AB), some material will be discharged from the mould, giving a moulding that is lighter than necessary. This situation leads to more trouble than just one light moulding. Since the one moulding is light and the exact weight is being fed into the machine for each shot there will be too much material in the machine for the next shot which will then come out heavy. In practice this excess material does not come through in the very next moulding but seems to build up in the machine and every so often a heavy moulding is made that will probably be scored, or even stick in the mould. With weigh feeding, it is necessary to have a long enough plunger forward time to prevent discharge.

Ball Check Nozzle

One type of nozzle valve used in injection moulding is the ball check nozzle. The advantage of the ball check nozzle, as with all nozzle and gate valves, is similar to the advantage of weigh feeding. That is, to mechanically seal any desired pressure and temperature in the mould. Since in any moulding operation the temperature of the plastic varies, and the rate of cooling may also vary, the gate will not always seal at the same point of its own accord. With a mechanical seal, the only variations will be the small variations in pressure drop through the heating chamber, causing only a small variation in the mould pressure. The ball check nozzle allows the plastic to flow into the mould but does not allow the material to discharge out of the mould. This is in effect sealing the mould when the plunger releases its pressure. As in weigh feeding the mould can be sealed at a higher pressure and temperature thus giving the

(*Continued on page* 134)



Production Story

TRADE publicity is intensifying with the gradual return to peace-time conditions, and its wake frequently involves the plastics industry. One such occurrence concerns the recent press announcement by the Pressed Steel Co., Ltd., of Oxford, that they would distribute miniature replicas of a standard refrigerator fashioned to function as a money-box. Money-boxes are by tradition associated with thrift, and the sales story here is that one can save with a Prestcold refrigerator.

Rootes Mouldings, Ltd., at Slough, were first approached in the middle of December, 1952, the contract was placed at the end of the same month. Samples were submitted four weeks later and approved the same day. The first press announcement by Pressed Steel appeared on February 5 and production had to be well under way by that date. We venture to suggest that on this job the moulder concerned proved that Britain can still beat a dead-line—and a very severe dead-line at that. What is even more remarkable is the next development in the story and its consequence to the moulder.

The response to the first advertisement was overwhelming. An anticipated demand of 30,000 from all advertisements was exceeded several times over. In addition, Pressed Steel were committed to a distribution of 20,000 at the Ideal Homes Exhibition. To avoid disappointing applicants for the money-box, Pressed Steel withdrew the copy which was to appear in further advertisements, and asked Rootes Mouldings if it was possible to double output. Rootes Mouldings replied that they could—and did, in the record time of 10 days. This of course entailed duplication of tools throughout. The first set of tools operated continuously 24 hours per day, seven days per week, until the second set of tools were completed.

The interesting feature here is the remarkable rapidity with which the job was tooled up in the first place and the doubling of production in the very limited time at the disposal to the moulder. All this was achieved without sacrifice of quality and even the speed with which the original design was executed did not result in any loss of technical efficiency. In fact, it was the rapid but accurate thinking at the outset which made it possible to double production in such a short space of time.

In Fig. 1 the unit is taken apart to show the design features. The body is moulded in a four-impression tool with a cavity depth of 2 in. A photograph of the tool is shown in Fig. 2. The length of each cavity is approximately 4 in., the width approximately $2\frac{1}{8}$ in.

Apart from the two ridges at the bottom of the refrigerator, which follows the design of the full-scale model, two further webs will be seen to be incorporated underneath the top of the unit. These two webs have a strengthening effect and also provide for recesses to be cut to act as keys when the door is inserted. The tool is designed to give a slit through which money can be dropped.

A wooden jig has been made to load the cavities. By priming the jig with powder scooped by a measure of known weight, and placing the jig over the moulded cavity, the charging of each cavity is reduced to a simple operation carried out in one movement. The jig is fitted with pegs to ensure that it is accurately aligned with the tool. Ejection of each moulded unit is effected by four pins. Body mouldings are cooled off in a jig (Fig. 3) to ensure accurate location of the lid when assembled.

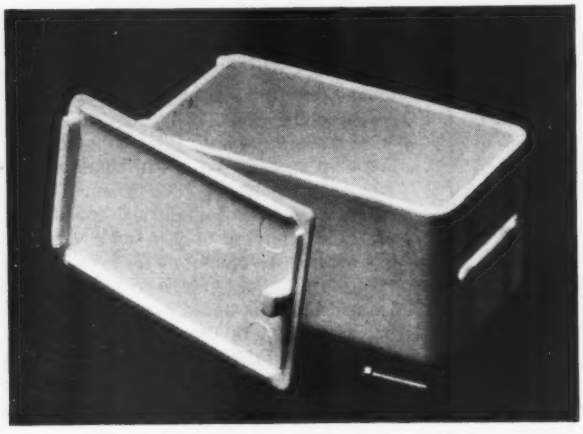


Fig. 1.—Body and door of refrigerator replica.

Fig. 2.—Tool open, showing operator air-blasting away scrap.

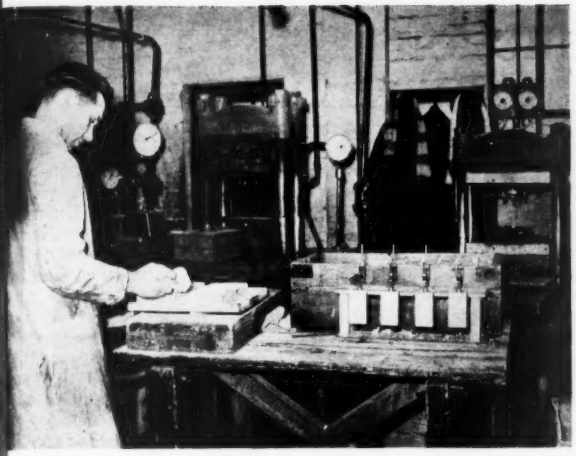


Fig. 3.—On the left is loading jig. On the right is the cooling device.

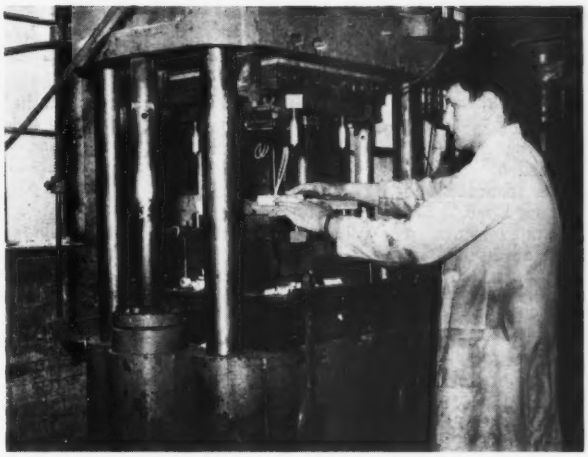


Fig. 4.—Loading the tool producing the door units.

For the door, again a four-impression tool is used, seen in Fig. 4. Here the design calls for rather tricky undercuts, designed to mate with the flanges cut into the webs on the top of the body. Ejection is by two pins at the bottom of each door, which means that each moulding is ejected at an angle, thus permitting the release of the undercuts without difficulty. The door moulding also incorporates a peg, which is afterwards drilled and tapped, and raised lettering, handle and house mark on the front.

After initial de-flashing by the press operator the units are passed to the finishing department. With the aid of simple jigs a hole is drilled at the bottom, which will ultimately carry the screw, and the moulded slot at the top is de-flashed through. Drilling here is necessary to cut through to two webs and also provides for accurate finishing. Recesses in the webs are machined (Fig. 5) to key the upper half of the door in position. The flash lines are ground and buffed.

The door is likewise finished, the peg at the bottom being drilled through (Fig. 6) and subsequently tapped. The raised lettering and house mark on the front are coated with silver paint (Fig. 7) to achieve a very attractive appearance.

When the complete unit is assembled the locking screw at the bottom is mechanically inserted. The powder which is used is supplied by British Industrial Plastics, Ltd., in their Beetle range of white urea.

Fig. 5.—The recesses into which the upper part of the door fits are machined in two movements on the same jig.

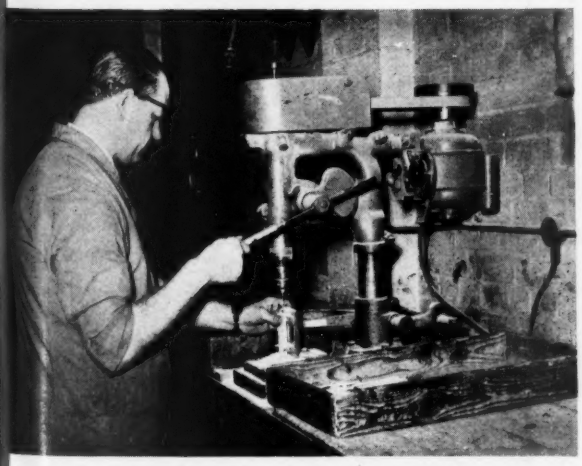


Fig. 6.—Drilling the hole at the base of the door, which is afterwards tapped to take the locking screw.

Fig. 7.—Operator is shown here applying metallic paint to raised lettering, handle and house mark on door.

New Productions

Babies' Rattles

One of the Coronation souvenirs which has won a special merit award by the Council of Industrial Design is the babies' rattle manufactured by Ornia, Ltd., 50 Station Road, London, N.W.10, which is illustrated below. The components of the rattle are in different colours and have been injection moulded in polystyrene. The head consists of two transparent balls, one larger than the other. Besides the usual beads, the smaller ball holds a coloured crown, and the larger one a head of the Queen. The decorated white handle bears the words: "Elizabeth, 1953."

Light Louvres

A novel idea for lighting fixtures is marketed by De Roy Plastics of Kingston-on-Thames, Surrey. As will be seen in the illustration below, it consists of an injection moulded unit, in diamond pattern, which can be joined together to form sections of any desired size, and are effectively used to screen fluorescent lighting fixtures.

Moulded in polystyrene, in a wide range of translucent and opaque colours, the louvres have been extensively employed in at least one major London store.

The mouldings are produced by J. F. Kenure Ltd., Faggs Lane, Feltham, Middx.

Decorated Tableware

Some of the familiar designs of plastics tableware moulded and marketed by Halex, Ltd., are now being produced with transfer decorations suitable for the Coronation. A three-piece children's set of egg cup, drinking mug and bowl is decorated with Windsor Castle transfers, and another four-piece set is decorated with transfers of H.M. the Queen.

Interior for New Bank

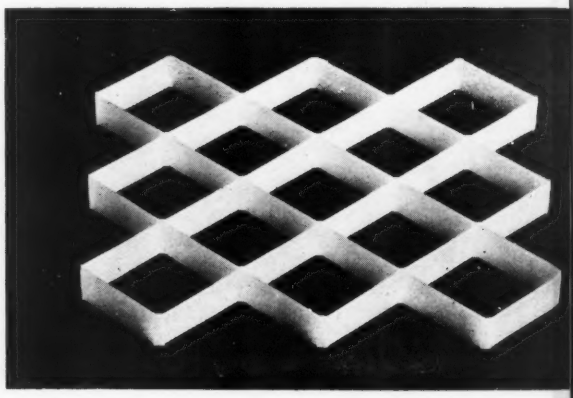
A branch of the Bank of America has been opened recently in Davies Street, London, W.1, and the architect, Mr. Hector O. Hamilton, F.R.I.B.A., has made extensive use of Formica plastics laminates. These materials, manufactured by Thomas De La Rue and Co., Ltd., 84-86 Regent Street, London, W.1, have been used on horizontal surfaces throughout the Bank for counter tops, desk tops and tables. Our illustration shows desks designed specially for the safe deposit vaults. These surfaces have been veneered with a bird's eye maple pattern of Formica.

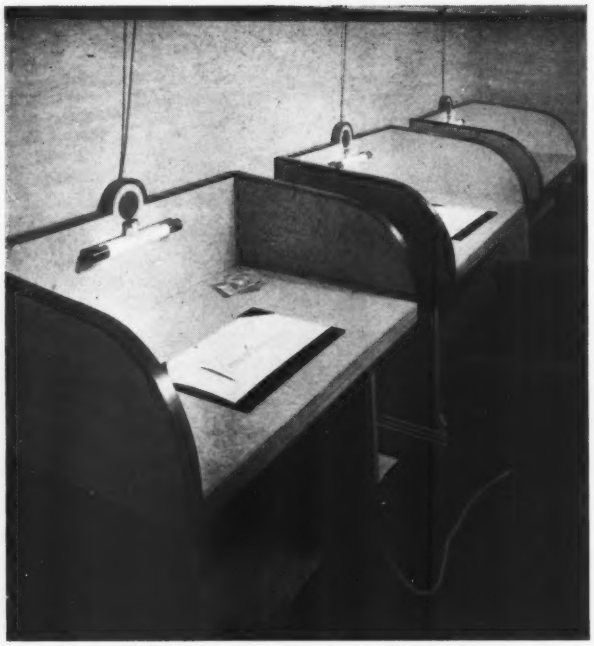
Aircraft Knobs

A black knob for an aircraft control lever has been moulded from cellulose acetate by Rootes Mouldings, Ltd., Trading Estate, Slough. It is an interesting example of

(Left) Coronation Souvenir baby's rattle.

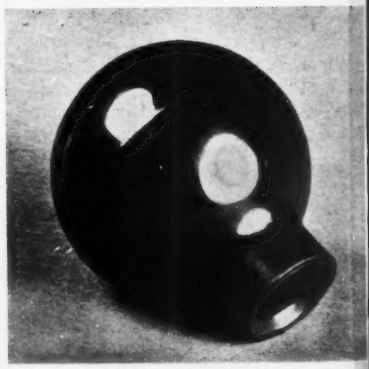
(Right) Louvre for lighting fittings.





Desks at the new London branch of the Bank of America.

(Right) Aircraft instrument control knob.



(Below) Hotel serving tray.

injection-moulding technique since it has very heavy wall thickness and also has an internal thread moulded in. A high degree of strength and excellent surface polish is attained by using this material.

Hotel Trays

Trays specially designed for the quick and efficient carrying of glasses are being moulded from wood-filled urea material by Universal Metal Products, Ltd. The deep rim allows glasses to move a little in transit without danger and also catches any drips caused by spilt liquid. These trays are moulded for various breweries; the one illustrated for Georges' of Bristol, is in pale yellow with the name filled in in red.

Coronation Souvenir Case for New Coins

Two of London's leading coin dealers will be using the case illustrated below for complete sets of coins of the new reign. These cases have been designed and are being produced by Resinoid and Mica Products, Ltd., Colonial Works, Mary Street, Balsall Heath, Birmingham, 12, for L. S. Forrer, Ltd., 175 Piccadilly, London, W.1, and for Spink and Son, Ltd., 5-7 King Street, St. James, London, S.W.1. The coins rest in a centre section compression moulded from royal blue urea which combines with the base tray to form a slide to enable the coins to be withdrawn easily. The case itself is moulded from transparent polystyrene, and allows the coins to be seen from both sides.

Safety Helmet and Badge for Metropolitan Police

A new safety helmet which is to be issued to police motorcyclists made its first appearance during the recent State visit to London of Marshal Tito. The helmet is the result of combined experimental work by the manufacturers, J. Compton, Sons and Webb, Ltd., the police and the Road Research Laboratory. It is based on the normal track helmet for racing motorcyclists, but since these are too rigid and too heavy for continuous use over many hours, everything has been done to make these helmets as light and comfortable as possible without impairing their protective properties. The inner shell, which consists essentially of shellac-coated cotton covered by layers of cork, is covered by a black p.v.c. leathercloth. The helmet has a flexible peak and special ear-flaps for use with portable radio transmitters.

The cap badge has been injection-moulded from transparent Diakon by Plasticraft, Ltd., Jubilee Close, Townsend Lane, Kingsbury, London, N.W.10, and is finished by metallic vacuum coating and finally by spraying on the reverse in black, giving the familiar three-dimensional effect associated with this technique. The metallization has been carried out by Fairtex, Ltd., 246, London Road, Romford, Essex. At present the badges are being made with the insignia of the Westminster Police and the City of London Police, but other designs are also to be made in the future. The Diakon badge is bonded to the p.v.c. leathercloth helmet by means of a specially formulated adhesive.

Decorated Bottles

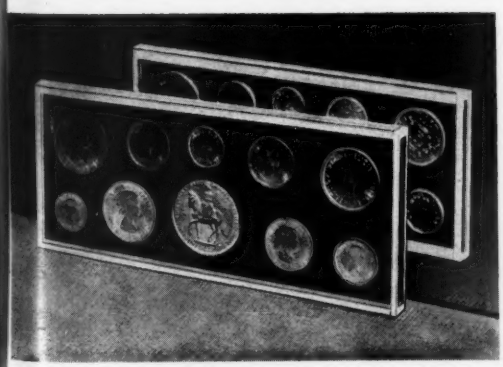
Included in the range of polythene containers manufactured by Fibrenyle, Ltd., 157 Dukes Road, Western Avenue, London, W.3, are the 5-oz. and 15-oz. bottles illustrated here. They are available plain or with the Coronation transfers approved by the Council of Industrial Design. They have been included in several public and trade exhibitions of approved Coronation souvenirs.

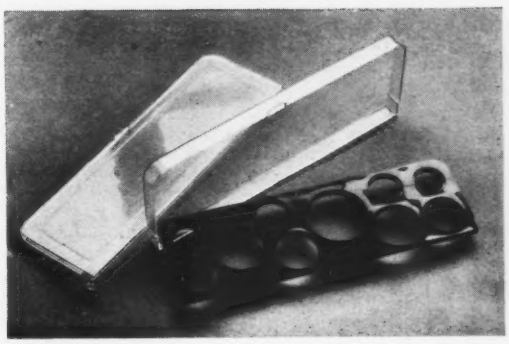
Coin Display Box

Another display box which has been produced for showing the new coins is manufactured by David Simmons (Plastics), Ltd., St. George Street, Hanover Square, London, W.1. The outer case consists of a hinged box moulded of transparent polystyrene with an integrally moulded hinge and a snap closure. Into this box fits another polystyrene moulding in black with recesses designed to fit each of the new coins. When this tray is removed the box also has re-use value for other display purposes, or for general home use.

(Above) Police motor-cyclists' helmet and badge.

(Right) Five ounce and fifteen ounce polythene bottles.



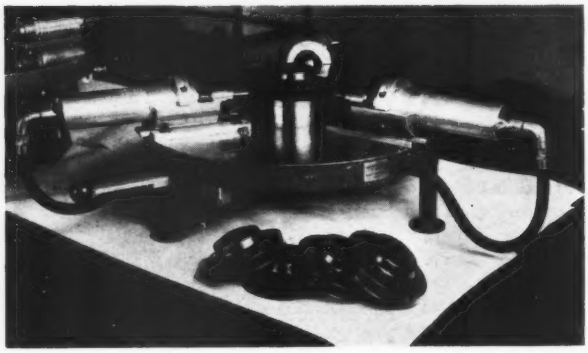


(Left) Coin display case, Resinoid and Mica Products, Ltd.

(Right) Coin display case, David Simmons (Plastics), Ltd.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes



(Left) A special assembly constructed by the Gildersleeve Design and Tool Co., incorporating Desoutter portable tools, for tapping phenolic lampshade holders.

AUTOMATIC RADIAL TAPPING MACHINES.—The illustration shows three standard Desoutter portable R.16/40 pneumatic tappers mounted on slides on a specially cast circular aluminium base, which have been used successfully for tapping phenolic lampshade holders by Ranton and Co., Ltd., of Brentford, Middlesex. A drilling operation, prior to the tapping, is carried out on a similar assembly.

The operation starts when the component is placed on the centre fixture, which carries a vertical air valve. The operator opens this valve by pressure through the centre hole in the component which allows air to enter via an Enots air controlled valve, through to the pneumatic cylinder. The plunger of the cylinder moving outwards, rotates a centre cam, one face of which opens the air controlled valve thus allowing a supply of compressed air to the three tappers. On removing the component from the fixture and releasing pressure from the valves, the air is shut off, allowing the cylinder to return to neutral and the cam to a starting position.

The tools are manufactured by Desoutter Brothers, Ltd., The Hyde, London, N.W., and the machines incorporating tools were designed and made by the Gildersleeve Design and Tool Co., of Reigate, Surrey.

NEW B.I.C.C. COMPANY IN AUSTRALIA.—B.I.C.C. announce that their plans for the formation of a subsidiary company in Australia have been completed, the company having been registered in Victoria with the name "British Insulated Callender's Cables (Australia) Pty. Ltd." The authorized capital is £A.1,000,000, of which £A.400,000 has been issued, and the registered office is at 84-88 William Street, Melbourne, C.I., Victoria, with branches in other Australian States. Sir T. Malcolm Richie, M.I.E.Aust., will be the first Chairman of the Board which will consist of prominent Australians and the B.I.C.C. Resident Executives in Australia.

BRITISH PRODUCTIVITY COUNCIL.—Copies of the report made by the Productivity Team on plastics moulding are still available and can be obtained from the Council at 21 Tothill Street, London, S.W.1, price 5s. 6d.

COLOUR TERMS IN SCIENCE AND INDUSTRY.—The British Standards Institution announces the publication of B.S. 1611/1953, a glossary of colour terms used in science and industry. An alphabetical index is included and copies are obtainable from the Sales Branch of the British Standards Institution at 24 Victoria Street, London, S.W.1, price 3s. 6d.

Mr. A. W. Todd.

E. K. COLE, LTD.—Mr. A. W. Todd has been appointed Technical Sales Representative and will be mainly concerned with the interpretation of customers' needs to the plastics divisions of the company. Mr. Todd was formerly Assistant Chief Estimator with British Moulded Plastics Ltd.

STEAM RAISERS.—A new leaflet, issued by G.W.B. Electrical Furnaces Ltd., Watford, Herts, deals with the Autolec Electrode Steam Raisers, self-contained units, which can be placed adjacent to equipment actually using steam. The machines are controlled automatically once they have been switched on and the pressure and output set to requirements.

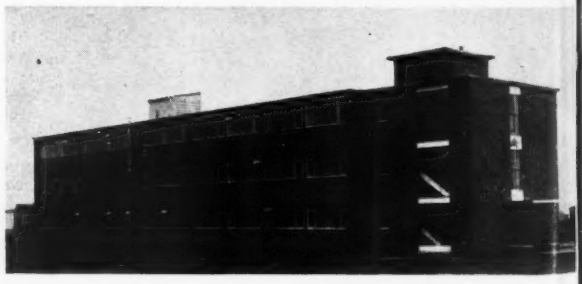
INDUSTRIAL PRODUCTIVITY.—A recent Government White Paper announced agreement between the U.K. and the U.S.A. on the allocation of about £3 million arising from the operation of the Mutual Security Agencies Economic Aid Scheme. Under the general direction of the President of the Board of Trade, this money will be devoted over a period of two or three years to increasing productivity. The allocation will cover advisory services to give special help to the smaller concerns, expansion of research into factors affecting the efficiency of the national economy, promotion of studies in technological subjects, publicity and loans to industry.

CLASSIFICATION OF RUBBER LITERATURE.—Technical literature for the rubber industry inevitably overlaps in part that for the plastics industry, and for this reason the Information Bureau Circular No. 410, issued by the Intelligence Division of the Research Association of the British Rubber Manufacturers will be of interest to readers of *Plastics*. The circular describes the system of classification that has been internationally agreed between rubber authorities in Europe and Asia. The system employed has been specially devised to meet the needs of the rubber industry and takes into consideration the significant developments in the field of synthetic rubbers.

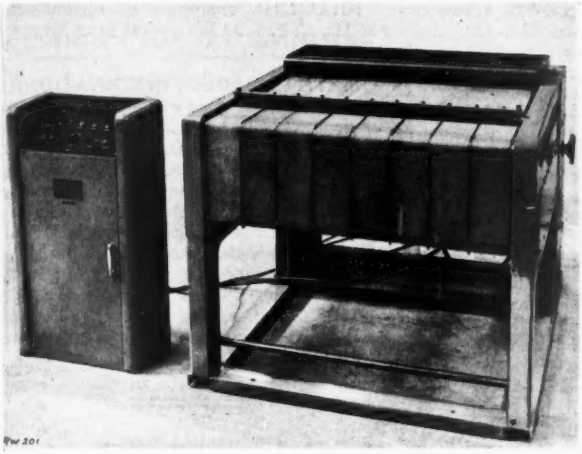
R. H. WINDSOR, LTD.—On March 1, 1953, the Sales Divisions of the company were moved to the Head Office and Works, at Leatherhead Road, Chessington, Surrey. The telephone number has been changed to Epsom 5631.

PETROCHEMICALS, LTD.—As will be seen in the illustration, a new block of Research Laboratories was opened on February 14 by Sir Robert Robinson, O.M., F.R.S., a director of the company. The laboratories, on the Partington Industrial Estate at Urmston, Manchester, form part of the overall technical department of the company covering scientific progress in the petroleum-chemicals field,

Sir Robert, during the course of his address at the opening, said that no chemical company worthy of its name could hope to succeed unless it had within its organization an active research department in constant touch with every field of industrial endeavour.



(Right) New research laboratories at Manchester for Petrochemicals, Ltd.



Rediweld type W.T.E. automatic bag-making machine, producing bags from polythene lay-flat tubing.

AUTOMATIC MACHINE FOR THE MANUFACTURE OF POLYTHENE BAGS.—"Rediweld" Type W.T.E. bag-making machine has been designed for the mass production of bags from polythene lay-flat tubing, both plain and gusseted tubing and incorporates a heat sealing unit, a cutter and a take-off device for the completed bags. A counter is also provided which can be set to count the number of welds or, alternatively, the number of cuts.

Basically the equipment consists of the actual sealing, cutting and feeding unit and a control cabinet which is fitted with all controls required for the accurate timing of each operation. Control cabinet and heat sealer are interconnected by means of two flexible multicore cables.

A new cutting device (patent applied for) has been incorporated in the equipment, ensuring a clean cut without dragging, which is particularly important in the case of very thin polythene film.

The equipment is unique in so far as each operation, by the simple turn of a switch, can be carried out separately. It is, therefore, possible to establish correct operating conditions prior to automatic running and to set up production with a minimum of wasted material.

Some output figures of the bag-making machine may be of interest:—

Maximum width of weld and cut, 39 in. (This can be utilized for a single large drum liner or, alternatively, a number of narrower bags can be welded and cut simultaneously by passing an appropriate number of units through the machine.)

Minimum length of bag, 2½ in.

Maximum length of bag, 108 in. (Bag length is adjustable infinitely between these limits and the average production rate for bags up to 12 in. in length is 600 welds per hour.)

Assuming that bags of 3-in. width are manufactured, at least 12 bags can be welded and cut simultaneously, i.e., the output equals 7,200 bags per hour in .002-in. material.

The W.T.E. has been designed for the manufacture of bags from lay-flat tubing up to .008-in. wall thickness (800 gauge).

The equipment has the following overall sizes: Heat sealer, 5 ft. by 4 ft. 6 in. by 3 ft. 10 in. high; control cabinet, 2 ft. by 1 ft. by 3 ft. 6 in. high.

BRITISH INDUSTRIES FAIR 1953.—The Fair will open at Earls Court and Olympia, London, and at Castle Bromwich, Birmingham, on Monday, April 27, and will close on Friday, May 8. There will be a plastics section at Earls Court as in previous years, where the British Plastics Federation will have an Information Bureau. Plastics machinery and materials will be located at Castle Bromwich, where certain member companies of the Federation will have a combined stand.

"PLASTICS" PUBLICATION DATE.—The May issue will be published on Wednesday, May 6, a week ahead of the normal date, and will contain special features devoted to the British Industries Fair.

DUNLOP PRIZES.—Two cash awards for successes in examinations on plastics technology were made in 1952 to employees of the Dunlop Rubber Company. The awards were given under the company's education scheme. A record total of 183 awards, worth £1,715 6s., was made during the year for successes in a wide range of examination subjects.

ASSOCIATED INSULATION PRODUCTS, LTD., has formed a subsidiary company in Canada named "Micanite Canada, Ltd.," the offices of which are situated in Granby, Province of Quebec. The new company in the initial stages will market the electrical insulation products manufactured by The Micanite and Insulators Co. Ltd., Walthamstow, and by the Mica Insulator Company, Schenectady, New York, these two companies being subsidiary companies of Associated Insulation Products, Ltd. Eventually it is proposed to manufacture such products at Granby.

SHELL CHEMICALS, LIMITED announce the commercial availability of their range of Epikote resins. Hitherto obtainable in development quantities only, from United States production, these resins are now being manufactured at a new plant which has just come into operation at Shell's Pernis Refinery in Holland. It is stated that production at Pernis will be in the region of 1,000 tons per annum and represents the first stage in the programme for the manufacture of these resins on this side of the Atlantic. Marketed in the United States as Epon resins, these products are reported to have established themselves, particularly in the surface coating and plastics fields where their unique combination of properties such as adhesion, flexibility, toughness and chemical resistance are of particular value. It is claimed that the epoxide resins, which the Epikote range typifies, represent a major advance in the synthetic resin field comparable to that made by the alkyds and vinyls.

SMALL INJECTION MOULDING MACHINE.—The "BR" bench plastics injection moulding machine has been produced in an attempt to provide the features of the injection moulding process in the simplest possible form. The intention has been to produce a very low cost machine for use principally by amateur handicraft workers, but the unit has also been employed by industrial organizations.

In operation a mould is placed under the nozzle of the machine, the container is filled with plastic material and is heated by a round electric heater 2 in. by 2 in. which is plugged in to any electric current. After 15 minutes warming up the plunger is pressed into the container by the handle and the plastic is injected under compression into the mould. Another mould is then put under the nozzle and the process repeated, the second injection only takes 1½ minutes to heat up before compression takes place.

The manufacturers, The Small Power Machine Co., Ltd., 4 Sunleigh Parade, Mount Pleasant, Alperton, Wembley, Middx., also supply a large number of stock moulds for use with the machine. These are a standard size 2½ in. by 2½ in. by 1 in. and are made in cast aluminium. Two small screws and wing nuts serve to locate and clamp the halves of the moulds together. The stock moulds make toy soldiers, animal figures, brooches, etc., up to a maximum weight of nearly ½ oz. Stock moulds are supplied with the machine or sold for 10s. each. The company also supplies small quantities of injection moulding materials to users, by far the most useful being polystyrene. The complete unit is sold for £8 10s., and weighs only 7 lb.

"BR" injection moulding machine.

Cascalite roofing material.

CASCELLOID, LTD., announce the production of a new roofing material Cascalite. The material is translucent and corrugated, made in standard sized sheets and is obtainable in a range of colours.

MR. J. E. FERGUSON HONOURED.—All connected with the plastics industry will no doubt be pleased to learn that at the Court at Buckingham Palace on March 11 last the Queen's most Excellent Majesty in Council, by and with the advice of her Privy Council, appointed Mr. John E. Ferguson, of James Ferguson and Sons, Ltd., to be High Sheriff of the County of Surrey, thus to take Custody and Charge of the said County according to Law. A signal honour to be bestowed upon a member of the plastics industry.

BRITISH INDUSTRIAL PLASTICS LTD.—Mr. Leslie M. Sanders, who for some time has been an area manager of British Industrial Plastics, Ltd., for the sale of moulding powders in the South-West, has been promoted to the position of Southern Area Manager.

MR. E. GROVE.—Director of James Grove and Sons, Ltd., and Past-Chairman of the Casein Button Manufacturers Association has been appointed to an independent Committee set up by the President of the Board of Trade to study the long term problem of the duty-free entry of machinery. The chairman of the committee is Sir Henry Wilson Smith, K.C.B.

"LONDON SPLENDOUR," flagship of London and Overseas Freighters, Ltd., incorporates decorative panelling manufactured by Saro Laminated Wood Products, Ltd. The illustration above shows the attractive effects that can be obtained. The SaR-ReZ range of liquid plastic finishes impart to wood surfaces a finish which is highly durable.

Lounge of the "London Splendour."

FRANCIS WILLIAM LEWIS, a director of A. Boake, Roberts and Co., Ltd., died on March 15, 1953, after almost 60 years' service with the company. After some years' experience in a City broker's office, he joined the company in 1894 and became a director in September, 1921. It was under his guidance that the company commenced the manufacture of fine chemicals and he was intimately concerned in the development of the business until the onset of his illness last November. He was widely travelled and had many friends in the industries and associations that the company serve. All who knew him were attracted by his enthusiasm and integrity. His colleagues, some of whom had worked with him for 50 years, knew him as a man of great kindness, wisdom and wide experience.

BRITISH PLASTICS FEDERATION.—At the Annual General Meeting held on Wednesday, March 18, the following were appointed members of the council for 1953/54: Chairman, Mr. C. S. Dingley, Vice-Chairman Mr. A. E. Skan, Honorary Treasurer Mr. H. W. Graesser Thomas. Extracts from the annual report were published in the March issue of *Plastics*.

New showroom for Halex Ltd.

HALEX, LTD., have opened a new London showroom at 9 Conduit Street, London, W.C.1. Some 250 different patterns in the Halex range are on display.

BRITISH RESIN PRODUCTS, LTD., announce bulk supply prices for polyester resins in the Cellobond range. Prices for 10-ton lots per pound are as follows:—

Resin			
13,002/191	...	...	4s. 2d.
13,002/211	...	...	4s. 5d.
13,002/13	...	...	4s. 11d.
13,002/2	...	...	5s. 5d.

POLYTETRAFLUOROETHYLENE.—Imperial Chemical Industries, Ltd., have published a 20-page booklet dealing with "Fluon" Polytetrafluoroethylene. Details of the properties and characteristics of the material are given and also useful information on the fabrication techniques, including cold moulding, pressure sintering, impact moulding, extrusion, welding and machining.

TRADE REFERENCE BOOK.—The 1953 edition of the *British Plastics Yearbook* contains a classified guide to the products of Britain's plastics industry. In addition to information on materials, products, equipment and companies, a new section deals with companies registered during 1952. The *British Plastics Yearbook* is published by Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1, price 30s. (postage 1s. 3d.).

IOCO, LTD., announces the appointment of Mr. H. F. Judd as General Sales Manager and a Special Director.

SIXTH CANADIAN INTERNATIONAL TRADE FAIR.—One of the largest world's trade fairs will be held in Toronto from June 1 to 12. To date United Kingdom companies have applied for approximately 56,000 sq. ft. of stand space. A number of Britain's leading publishers of business journals are combining in the display of 55 of their most widely read technical, trade and specialized publications. This is to give the world's buyers more information about Britain's products and services, and among Temple Press publications to be represented will be *Plastics*.

Forthcoming Meetings

April 13.—Annual Luncheon, Plastics Institute, Midlands Section, Queen's Hotel, Birmingham.

April 14.—"The Maintenance of Process Plants," G. C. Allfrey, B.A., M.I.Mech.E., M.Inst.F., followed by discussion on the report of the team on plant maintenance which visited the U.S.A. in 1952. Incorporated Plant Engineers, at Royal Society of Arts, John Adam Street, Adelphi, Strand, 7 p.m.

April 15.—"Applications of Hydraulics," D. V. Rowles, B.A. (Cantab.), A.M.I.Mech.E., of Fielding and Platt, Ltd. Incorporated Plant Engineers, Bull Hotel, Rochester, 7 p.m.

April 15.—Glass Fibre Reinforced Plastics Symposium: "Resins and Techniques," B. Parkyn; "Products and Applications," A. M. Dobson, B.Sc., A.Inst.P. Plastics Institute, London Section, Waldorf Hotel, Aldwych, London, W.C.2, 6.30 p.m.

April 15.—Annual General Meeting and Smoker, Plastics Institute, Scottish Section.

April 15.—"Synthetic Resins in the Foundry," P. G. Pentz, B.Sc. Plastics Institute, Southern Section, Polygon Hotel, Southampton, 7.30 p.m.

April 17.—"Petroleum Chemicals as Raw Materials for Plastics," F. Chapman. Plastics Institute, Midlands Section, James Watt Memorial Institute, Great Charles Street, Birmingham, 3, 6.30 p.m.

April 22.—"Epoxy Resins and Their Applications," W. J. Marmion. Plastics Institute, North-Eastern Section, Lecture Hall of The Mining Institute, Newcastle, 7 p.m.

April 24.—"Practical Do's and Don'ts in Tool Design" (Transfer Moulding), J. Butler, A.M.I.Mech.E., A.M.I.B.F., F.P.I. Plastics Institute, North-Western Section, Engineers Club, Albert Square, Manchester, 6.45 p.m.

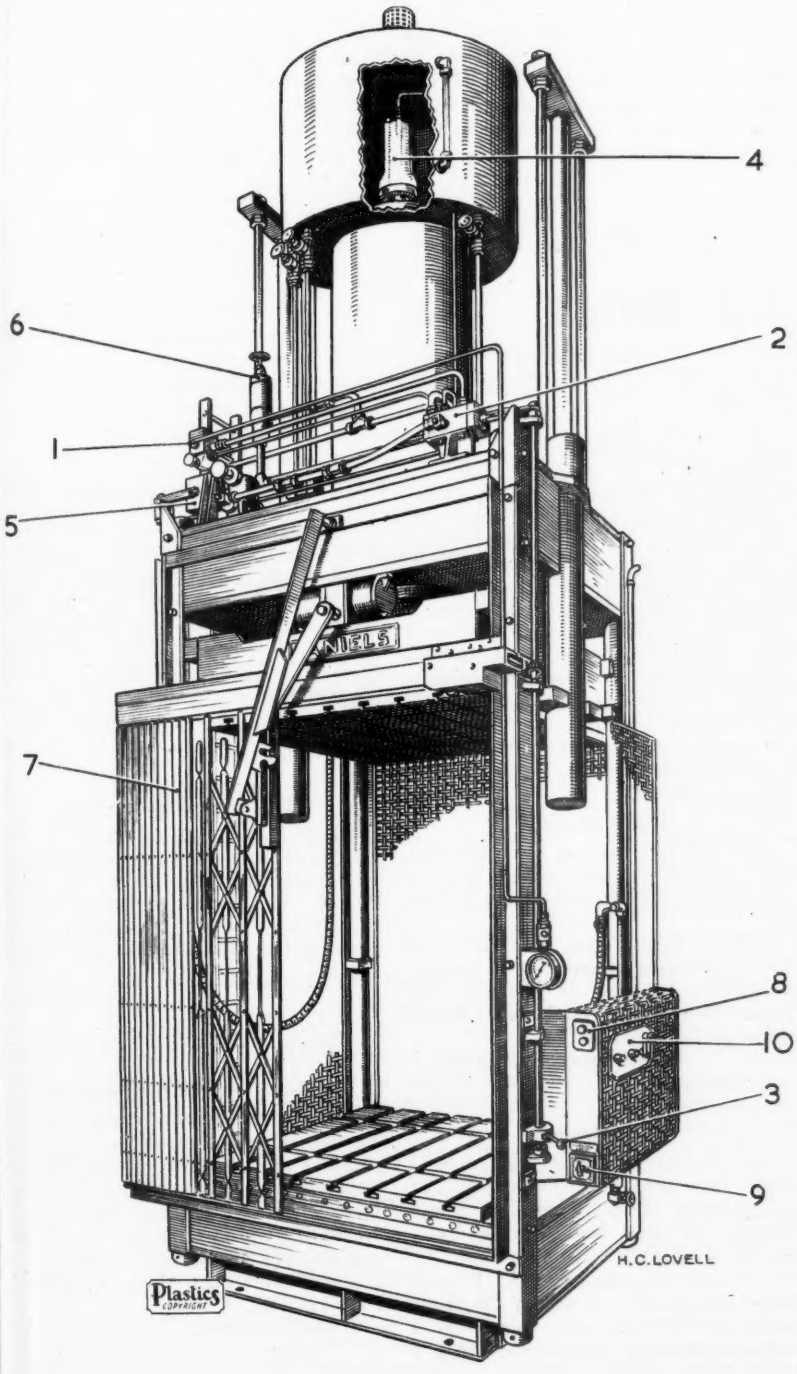
May 4.—"Standardization of Shellac and Lac Products," Dr. W. G. Ferguson. Society of Chemical Industry, Plastics and Polymer Group, joint meeting with London Section. Burlington House, Piccadilly, London, W.1, 6.30 p.m.

May 6.—Annual General Meeting, Plastics Institute, Yorkshire Section. St. Mark's House, 186 Woodhouse Lane, Leeds. 2.

Machines for the Industry

Daniels 100-ton Low-pressure Press for Glass Fabric Moulding

The First Press Designed and Produced in Britain for Moulding Reinforced Plastics Materials



THE machine described in this article is the first of a range of presses to be produced by T. H. and J. Daniels, Ltd., Stroud, Glos, designed to mould reinforced plastics materials, such as those having a glass fabric base. Up to the present time, as quantities have been small, mouldings of these materials have normally been made by the relatively slow method of "laying up" by hand, a procedure which is not suited to large-scale production. Although the cost of a press and the associated mould is relatively high, equipment such as this is necessary for high-speed production. An automatic preform machine may take the place, in some instances, of hand laying up.

Due to the low specific moulding pressure required, and the large size of components made by this process, the press is much larger than a conventional powder moulding press, having tables 4 ft. x 3 ft., a maximum daylight of 7 ft., and a 4-ft. stroke. It is of the conventional four-column type, with fabricated steel tables and head, the moving table having guides which fit around the columns.

No provision has been made for heating the moulds, as, due to their size, it is more convenient to have heating elements or steam ways built into the moulds themselves. In order to prevent heat from the moulds affecting the press, both the fixed and the moving tables are drilled for cooling water. Tee slots are machined in the tables for mould securing purposes.

The press is designed as a self-contained unit and has a two-section van-type pump driven by a 12½-h.p. motor mounted in the press head, together with all the necessary hydraulic piping and valves. The working pressure is 1,000 lb. per sq. in., which gives a maximum moulding pressure of 100 tons

1.—Reducing valve for pressures between 10 and 100 tons.
2.—Piston-type valve for control of press.
3.—Handle operating piston valve.
4.—4½-in. diameter pre-filling valve.
5.—Slowing valve to permit gentle closing of press.
6.—By-pass delay valve.
7.—Air-operated sliding screen.
8.—Push-buttons controlling screen.
9.—Main switch controlling electric motor.
10.—Hand-operated star-delta starter.

and an opening load of 6.3 tons. By means of the reducing valve (1), the moulding pressure may be set at any figure between 10 and 100 tons without affecting the opening load.

Control of the press is by a piston-type valve (2), which is operated by the handle (3). The press is fitted with a 4½ in. diameter prefilling valve (4), and its speed for both opening and closing is 5 in. per second. In order that the moulds may close gently, a slowing valve (5) is fitted, by which the speed over the final 18 in. of stroke may be reduced to any desired figure. The parting speed may also be controlled, in order to avoid damage to the mouldings. At the top of the stroke, the last 2½ in. of ram movement is at a reduced speed so that when hanging bar ejection is used the mouldings are not damaged by the ejector pins.

The slowing valve (5) operates by controlling the speed at which oil is allowed to flow into or out of the return cylinders. It is operated by a cam on the moving table and the speed may be preset by the operator. As it is not usually desirable to restrict the opening speed for the full distance of 18 in., the slowing valve is by-passed by a delay valve (6). This valve can be set so that the slowing valve operates for a period of up to 5 sec. after the control lever (3) has been moved to the "press open" position. After this time has elapsed, the table will open at the full speed of 5 in. per second, until the last 2½ in. is reached, when it may again be reduced for ejection purposes.

The machine is fully guarded, having fixed screens at the back and sides, and an air-operated sliding screen (7) at the front. This screen, which is operated by the push buttons (8) is interlocked with the hydraulic circuit, so that the press cannot be operated unless the guard is closed.

The electric motor is controlled by a main switch (9) and the hand-operated star-delta starter (10) fitted on the right-hand side of the machine.

As all the hydraulic valves are mounted on top of the press, in what would be an inaccessible position, a ladder is fastened to the side of the press, and the valves which may need to be adjusted, such as the pressure reducing valve, slowing valve and delay valve, can be adjusted from the top of this ladder.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

Reinforced Fibre-glass Mouldings

SIR,—In your Editorial of February this year you have surveyed the progress in the use of fibre-glass reinforced resins.

We should be interested to learn more of the possibilities of fibre-glass mouldings and we should very much appreciate your advice as to which companies are likely to undertake work of this kind. We intend to replace a sand-cast aluminium frame about 20 in. long and 8 in. wide, also the cover plates for same.

It might also be helpful if you gave us the name of the manufacturers of a press specifically designed for the making of glass-fibre resin mouldings.

J. W. HALPERN AND PARTNERS.
110 Jermyn Street,
London, S.W.1.

Bead Making Machine

SIR,—We have had an inquiry from customers of ours in New Zealand who desire to purchase some machinery here for the manufacture of spherical beads from plastic. The actual inquiry reads:—"The machine is required for the automatic manufacture of beads from clear plastic. The machine should be similar to that which makes ball bearings and the raw material would be clear capillary tubes."

We would be obliged if you could indicate to us the names of any firms in this country who you think might be able to supply such machinery.

DERBY AND CO., LTD.
11-12 St. Swithin's Lane,
London, E.C.4.

Machinery

SIR,—We have received an inquiry from our Sydney branch for the following three small machines:—A laboratory size extruding machine for cellulose acetate and polyvinyl chloride, a hopper-fed machine for the grinding of plastic rod into beads of ½-in. diameter and a machine for turning wooden beads to a ½-in. diameter. If you are able to give us any information on British manufacturers of such machines we would appreciate your advice.

ABEL, LEMON AND CO. PTY. LTD.
109 Fenchurch Street,
London, E.C.3.

Model Making

SIR,—We are requiring some information concerning model makers and we are wondering if you will be able to help us.

Will you kindly let us have the names of any manufacturers who prepare models of machines in "Perspex" or glass. We particularly require models to show working interiors.

ROWLINSON-BROUGHTON.
2, Mosley Street,
Manchester, 2.

U.-F. Fertilizer

SIR,—In order to further our investigations into fertilizers for sports turf management we are anxious to obtain supplies of urea formaldehyde, as a source of nitrogen.

We have approached B.X. Plastics, Ltd., and the Burton Button Co., Ltd., and both firms are unable to help us. I wonder, therefore, whether you are in a position to suggest to us a firm who might be able to supply say up to 1 cwt. of such material?

THE SPORTS TURF RESEARCH INSTITUTE.
St. Ives Research Station,
Bingley, Yorkshire.

Plastic-lining of Oil Tanks

SIR,—We have read with interest the letter in the January issue of *Plastics* from WJ of Norway, relating to coating materials for use as lining for tanker fuel tanks. We have certain materials for use in this field, not identified with those referred to, but which may none the less be of interest to your correspondent.

SEMTEX LTD.
Kingsbury Road,
London, N.W.9.

Self-adhesive Plastics Signs

SIR,—Could you let me know the address of the firm who make Plastisigns, interchangeable, self-adhesive, letters and figures. The letters and figures are cut out from thin flexible plastic sheet material and will adhere to any smooth surface.

J. MOCOGNI.
22 Tatham Street,
Sunderland, Co. Durham.

Plastic Material for Spraying

SIR,—Would you be so good as to give me the address of suppliers of a plastic material which can be sprayed on wire frames giving a watertight jacket to a set piece which is illuminated internally. I would like any information on this process that you may be able to offer.

ART MODEL MANUFACTURERS.
11 Pier Hill,
Southend-on-Sea,
Essex.

Polyvinyl Sleevings and Wire Coverings for Electrical Insulation

By E. E. HALLS

POLYVINYL chloride or copolymer sleevings and tubings of commendable quality were imported over fifteen years ago. They proved to be very satisfactory for electrical insulation, especially where both high insulation resistance and high electric strength were sought. The material solved many existing problems and brought many new ones to be solved or taken care of by re-design or re-planning. The interruption in foreign supplies during the war gave excellent opportunities, which were well exploited, to develop appropriate grades of p.v.c. for extrusion in this country and a wide range of sleevings became available to satisfy the urgent needs for the tele- and radio-communcations industries. The range catered for the diversity of requirements with respect to internal diameters, wall thicknesses and colours, the latter being necessary for identifying circuits. Covered conductors, including some of the smaller gauges of copper and tinned copper wires, both single and stranded, were also developed and extensively employed.

The growth of this section of the plastics industry is a reflection on the merits of the sleevings and wire coverings produced. The new materials were used where the established ones did not entirely fulfil requirements, for new designs, and to a considerable degree as a replacement for the older-established insulating systems. All these applications have given opportunities for assessing the p.v.c. extruded insulation in relation to its merits with respect to manipulability in the shops assembling electrical apparatus, and on sites where apparatus and equipment is installed, as well as with respect to performance. Research and production developments continue; extruded p.v.c. still leaves something to be desired, but the needs are appreciated by producer and user alike, so that, on the one hand, improvements are under development and, on the other, design and assembly are given attention to take care of any shortcomings.

Insulators Superseded by P.V.C.

In examining the present position, a number of questions arise, viz., what are the insulants superseded by extruded p.v.c., what shortcomings in them have been eliminated by the new material, what are the deficiencies of extruded p.v.c. and how far can they be improved upon or offset by design or assembly method, and what fields of application have yet to be satisfied? These points will be briefly discussed.

Textiles are the basis of the insulation formerly employed. Sleevings of this type generally comprise woven cotton tubings, varnished. For maximum electric strength, " pin-holes " are avoided by filling the surface, for example with starch size, before coating with varnish. A long oil varnish based on linseed oil is normally employed, but this deteriorates under hot damp conditions. For tropical applications, a china wood oil varnish containing gilsonite or similar hard bitumen is used. Natural silk replaces cotton for smaller sizes and for higher grades, and a lapped silk tube instead of woven type probably gives maximum performance.

The most serious drawback of all textile sleevings is relatively low electric strength (in the direction through the wall thickness) and most of them may have low insulation resistance under damp conditions on account of the " wick " effect of the textile. They are not entirely free from corrosion tendencies, due mainly to acidity from the varnish constituents and a tendency for such acidity to increase with age. The upper limit of working temperature is about 60° C., above which mechanical strength deteriorates appreciably. There is a lower limit to wall thickness and to internal diameter, even with the silk varieties.

When used on units that have to be impregnated in wax or varnish, the ordinary varnished textile sleevings harden and are not satisfactory as they result in lead-wires snapping off short. The alternatives are to use plain textile, waxed textile or so-called " semi-treated " sleeving. The latter is an unsized cotton sleeving, treated with a very long oil varnish. Again, for processing that involves pre-drying the unit at 110° C. and impregnating with varnish not above 110° C., some users specify special varnished sleevings that will withstand the conditions without undue hardening or loss of strength, but these are not easy to purchase, and require rigid inspection control.

Cable Covers

Regarding coverings for cabling, the latter may use plain or tinned copper wire, which again may or may not be enamelled (B.S.156), with two or more lappings of textile. The textile may be cotton or acetylated cotton, natural silk, or rayon, the latter in turn being cellulose actetate or regenerated cellulose. Choice is determined not only by insulation requirements, but also by permissible radial dimensions. Further, in order to give protection against moisture absorption in environments subject to fluctuating humidities and from the noxious gases of industrial atmospheres, as well as to bed the textile down firmly so that it does not ruckle or fray, these cablings are impregnated. A pale-coloured beeswax is the conventional impregnant, although some users have modernized to a microcrystalline hydrocarbon wax, while quite a few have adopted a cellulose lacquer (usually acetate base) for the purpose. The waxes employed are slightly tacky and enable a cable form comprising a bunch of covered conductors to be neatly shaped and firmly bedded down without the slip of one conductor over another when they are bound and tied with waxed linen yarn. The lacquering, which does not possess this property, has, however, the advantage that dust and dirt does not so readily adhere to it.

Using non-enamelled wires, these textile-covered cables need to be very skilfully covered if shorting, particularly at bends, is not to occur due to slippage of the textile. The impregnation needs to be efficient, for maintaining a reasonable level of insulation under humid conditions. At the same time, it must be remembered that the waxing reduces the rate of moisture absorption rather than preventing it. After exposure to very moist atmospheres, the rate of recovery is also slower than with dry or lightly waxed textile, and this can be a drawback in service.

The radio industry has used copper-covered tinned copper wire heavily lacquered with pigmented cellulose, suitably coloured with pigment. This is an expensive insulation but it does cut neatly without fraying at the ends.

The principal criticism of the textile-lapped form of insulation is degradation after a long period of service. The cabling " hardens " with time, and the textile loses strength. This causes insulation troubles if the cabling is subjected to movement, which can be caused by vibration, which is inevitable

if changes or repairs have to be made. The textile is enbrittled, breaks away and causes low insulation or short circuiting between conductors. The deterioration is probably one of acid degradation of cellulose resulting from absorption of sulphurous gases from industrial atmospheres. This shortening, of course, is only of great importance in electrical equipment of the long-term category, which includes telecommunications apparatus and electrical control equipment generally. Improvement in insulation is sought for these applications to give even longer service life and to reduce maintenance effort.

Requirements for Heavy-duty Services

Before dealing with the newer p.v.c. insulation, it is useful to survey briefly the technical requirements for the more exacting service conditions, which can concisely be termed " telecommunications " applications.

The first necessity can be defined as " inertness." The insulation should be neutral in reaction and without chemical or physical effect upon the other materials that it may contact in the component or assembly.

Traces of acid or alkali, and neutral salts, can be directly corrosive to the metals likely to be contacted (copper, brass, bronze, nickel silver etc.), or corrosive under electrical potential. Further, they may lower insulation, or cause deterioration in mechanical strength. The material must not adversely affect or contain ingredients that can deteriorate other insulating materials (e.g., enamel coverings on wire) or finishing schemes (e.g., enamel on metalwork or lacquer on woodwork) by physical action through contact.

The second criterion can be described as " stability," which implies retention of inertness, dimensions and other qualities during service life. Mechanical properties of strength and flexibility should remain constant, power factor, electric strength and insulation resistance should be retained at constant level, dimensions should not alter and thermal and photo-ageing should not be apparent.

Thirdly, electrical properties are naturally important but the needs in this direction vary quite widely with the application, and not by any means do they need to be of the highest order for all purposes. At the same time, it is desirable that electrical characteristics be of a known and assured magnitude, without wide variations from one batch to another, or from one source of supply to a second. When the frequencies used are high, insulants having low loss factor and high electric strength are necessary; generally p.v.c. would not satisfy the needs in such fields. For lower frequencies, as in telecommunications applications, low loss is not essential as long as power factor and permittivity are constant; the electric strength needs vary considerably, but a high level of insulation resistance, especially of insulation under damp conditions, is an essential to all applications.

Fourthly, mechanical properties must be right although difficult to define. Tensile strength, flexibility, toughness and compressibility all have a precise contribution to make, the values for each being dependent upon the conditions of use. Permanence of these qualities is, of course, essential.

Finally, the influence of service conditions upon the level of chemical, physical, electrical and mechanical properties must be such that negligible lowering of quality occurs. The ardours referred to include the effect of heat generated in and dissipated by the equipment itself, fluctuations in ambient temperature and in humidity, and they impose wide variations from hot dry to damp cool conditions, and include periods of heavy condensation. Moisture absorption during periods of high humidity and/or condensation can encourage the absorption of sulphurous gases or other fumes from the atmosphere. Marked water absorption and loss of insulation, physical swelling or contraction with distortion or rupture, loss of volatile ingredients such as plasticizer from thermoplastic, with resultant hardening or shrinkage: these are changes to be guarded against.

Influence of Plasticizers

In order to visualize how far extruded p.v.c. satisfies the requirements needed—the ideal material to fulfil all the criteria cannot be expected in practice—its composition and properties warrant some consideration. P.V.C. itself is a hard, rigid material, and it has to be heavily plasticized in order to yield the degree of flexibility, or range of flexibilities, required in insulating sleevings and wire coverings. A practicable difficulty arises here, namely, the development of suitable softening agents that are compatible with p.v.c. to give compositions that are both inert and stable. Unsuitable plasticizers are associated with several defects in the finished material, and these can only be avoided by ensuring correct selection.

This question of plasticization is perhaps the most important factor in the success or otherwise of extruded p.v.c. insulation, in the preparation of the sleeving or covered wire, in its storage, in the assembly shop and in service. Many of the plasticizers normally employed are unsuited for the electrical applications. Some of them tend to sweat out of the material to create an oily film; on occasions, this has been found to occur during a short period of storage. Others evaporate or volatilize under normal conditions of usage. Warmth or dampness or both, and fluctuations thereof, accentuate these processes. Dimensional instability is one direct result; a shrinkage in length is usual. An increase in hardness is another.

The answer to this weakness is the choice of a non-volatile plasticizer, and this can also be a non-sweating one. In this way, a relatively stable p.v.c. is quite practicable, with a degree of flexibility determined by the amount of plasticizer incorporated. From a range of grades, the one of appropriate consistency can be selected on a basis of hardness value, tensile strength or elongation. Sleevings and wire coverings made from such material retain their flexibility and dimensions quite well under service conditions, and available grades can be selected to withstand impregnating process temperatures up to 130° C. very satisfactorily, and up to 150° C. reasonably well.

Migration of Plasticizer

Another shortcoming associated with plasticization is that commonly referred to as " migration of plasticizer," i.e., the transfer of plasticizer from the p.v.c. into any other thermoplastic material in contact with it; this transfer continues until equilibrium is established. Plasticizer from p.v.c. of high plasticizer content will migrate into one of lower value. It will enter polythene and ruin its electrical low-loss characteristics; it will transfer to cellulose acetate and other thermoplastic products such as films, sleevings or mouldings; it will be absorbed by finishes of cellulose lacquer or enamel, rendering them sticky; it will also migrate into shellac compounds or coatings, and into many air-dried paint and enamel coatings.

This migration problem is one that has been solved by the development of non-migratory plasticizers such as sebacates and adipates, and by the establishment of processes for satisfactorily incorporating such materials in p.v.c. These plasticizers are also relatively non-volatile and non-sweating so they are not easily expelled from the p.v.c. mix by heat or humidity, so that when they are employed, the stability requirements can also be satisfied.

In using these heavier plasticizing compounds, propensities towards corrosion of the copper-rich metals must not be overlooked, i.e., free fatty acid radicles must be within a safe limit. Otherwise the plasticized p.v.c. will be corrosive towards copper and its alloys, particularly under conditions of warmth and humidity.

Another property inherent in p.v.c. is the lack of stability

of the molecule under conditions of exposure to light, warmth and dampness; some degradation with the formation of traces of hydrochloric acid and loss in electrical quality tends to result. This tendency is taken care of by "stabilizing," to which end an inhibitive chemical is included. Lead compounds are usually employed for this purpose, but calcium salts and/or organic derivatives are used in special circumstances. With the electrical grades of p.v.c., the chemical and physical nature of the stabilizer, and the amount and mode of incorporation, may all have a profound influence upon quality. The influence of stabilizer can aptly be assessed by power factor measurements at elevated temperatures, recording temperature curves for power factor/time relationships.

A mechanical fault found in p.v.c. sleevings and wire coverings is an "extrusion defect" revealed as a line of weakness or split down the length of the product. It results from lack of process control of the temperature and/or speed of extrusion whereby the two "edges" of the material leaving the extrusion die do not immediately knit or weld together. Such a defect can be troublesome in practice because the fault may not be apparent to a raw material inspector who can only examine the end of the coil, yet it comes to light during usage of the material in the manufacturing shops, with consequent delays. The establishment of reliable supplies of the material from sources operating good process control is the only remedy.

This treatment of the quality of p.v.c. from the compositional aspect has, it is hoped, indicated shortcomings to be avoided and the general make-up for a stable flexible compound for electrical purposes. In using such a material, natural physical or mechanical characteristics must be appreciated, and apparatus design or assembly methods evolved accordingly.

From this point of view, "thermoplasticity" defines this natural quality in p.v.c., and it must be recognized in design by engineers and in assembly methods by planning engineers and manufacturing shop supervision. It imposes a temperature restriction as well as a compression load limitation, and these depend upon the manner in which the material is used as well as upon the grade selected. The nature and quantity of plasticizer again determine the letter. Manufacturing operations concerned are those such as associated with soldering and impregnation processes (including baking for pre-drying), any which involve clamping including tying or binding, and wiring generally, with special reference to stretching around bends and sharp corners. Design should be towards ensuring safe usage in these respects, and must bear in mind that extent of plastic flow increases with use in temperature. Ambient temperature in service must be regarded, as well as heat generated in the operation of the equipment.

The influence of pressure transversely applied to a p.v.c. sleeved or covered conductor is depicted diagrammatically in Fig. 1. This shows the tendency for the conductor to "migrate through" the p.v.c. insulation. The grade of p.v.c. used with respect to hardness must be selected to suit the pressure/temperature conditions imposed, or conversely, the pressure imposed must be reduced to a value that the material will safely withstand. Sharp bends and straining around the edges of rigid components must be avoided, because the pressures that can be thereby developed are indeterminate. Cable forms comprising a number of conductors bunched together and firmly tied must not be tied with string that gives a line-pressure otherwise there will be a strong possibility of plastic flow, reduced insulation and even of direct contact between conductors. Taping is preferred, and a woven nylon tape is being successfully employed. Special fixings in the form of p.v.c. cleats have also been developed for the purpose, and should prove satisfactory in long period service.

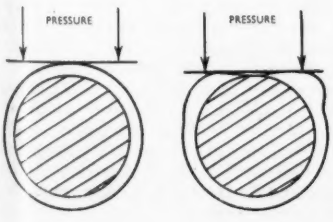


Fig. 1.—Showing flow of insulation when pressure is applied to one side of flexible extruded p.v.c. covering on metal conductor.

Fig. 2 indicates diagrammatically what can happen to a p.v.c. covering over a conductor at a sharp end. The tendency at *A*, where considerable pressure is developed on the insulation when the bend is made after covering, is for the insulation to become progressively thinner on the outside of the bend, until finally the wire cuts right through the insulation, as shown at *A2*. A more gradual curvature, as shown at *B*, overcomes this difficulty.

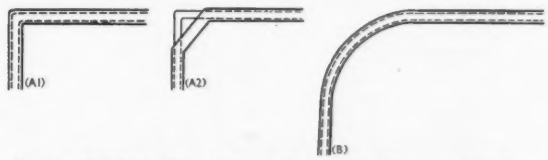


Fig. 2.—Showing effect of sharp bend on flexible p.v.c. covering.

In soldering operations, the minimum of heat and of time of heat application are first essentials. The lowest melting soft solder (i.e., 60 per cent. tin, a standard grade) is advocated, and designs arranged for a maximum soldering time of about six seconds. In any case, heat is conducted back along the conductor, and, increasing the temperature of the p.v.c. covering, it increases its plastic flow for a given pressure. Again sharp bends near the soldering point must be avoided, as well as pressure of the covered wire against any rigid component such as a pillar or post, a tag, a component or edge of a panel or chassis. Fig. 3 at *A* depicts a soldering operation adjacent to a sharp bend, and the condition shown at *B* is almost inevitable. The curvature indicated at *C* is satisfactory for the soldering but is still likely to produce reduced insulation or shorting to a rigid component if it contacts it during the soldering period.

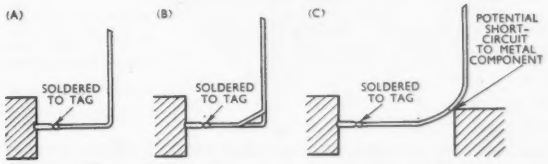


Fig. 3.—Effect of soldering on p.v.c. covered conductors near sharp bends.

These troubles can be avoided entirely by using the harder grades of p.v.c. covering and taking the obvious precautions suggested. On the other hand, using the more flexible qualities, the covering can easily be pulled back by means of pliers while the soldering is done and then allowed to return into position. This is an attractive property and quite acceptable for soldering straight lengths. The harder grades need to be "skinned" with cutting pliers before soldering.

Where the dangers of plastic flow of the covering cannot assuredly be eliminated by design and process precautions, the present solution is to use the conductor wire having an extruded p.v.c. covering, overlaid by one or two laps of textile, the latter being bonded by a coating of cellulose dope. The textile employed is regenerated cellulose. It may be that a future answer will be a thin covering of nylon extruded over the p.v.c., but it is much too early to predict the performance of such a combination. It is, however, known that such a covering restrains migration of plasticizer from the p.v.c.

The cellulose dope referred to as a bond for the textile covering is normally an acetate base lacquer. Work has yet to be done on polyvinyl lacquers in this application. There are, in fact, a number of features calling for close process control in the lacquering operation. Only a thin coating is required, and an even contour is essential. At the same time, the lacquer and technique of applying it must not be such that any ingredients in it, solvents in particular, affect the p.v.c. Excessive thinners may diffuse into the p.v.c., and may take plasticizer from the latter through to the conductor. A combination of excess solvent and incorrect plasticizer can cause heavy corrosion of the copper. It will be seen therefore that, as with the p.v.c. and its application, correct choice of material, development of process, and its maintenance are essential.

As a covering, p.v.c. provides the electrical properties required, i.e., a specific power factor, high electric strength, good insulation resistance and retention of the latter under damp conditions. By selection of grades of proper composition, dimensional stability is sufficient for the purpose in question. Thin walls and small internal diameters are procurable in sleevings, and reasonably thin extrusions with continuity are practicable as wire coverings. The material has shown no susceptibility to deterioration under service conditions involving industrial atmospheres. Colours are obtainable for distinguishing cabling. The economic position is satisfactory in comparison with the older products.

Where mechanical separation between conductors is required, the lacquered textile lapping is an answer, and from use in the field over a few years has given promising results. Superiority over the directly textile-covered wire may be considered as established. By adopting this kind of cabling, enamel coating of the base wire is not necessitated, and this eases the soldering problem and reduces the number of "dry-joints" thereby. Impregnation of the cable after forming may be omitted. Everything considered, there is great confidence in this material giving better insulation, and therefore less maintenance and replacement effort and longer service life.

The extruded p.v.c. sleeving has largely replaced the impregnated or coated textile sleevings in the light electrical industries. The shortcomings found in practice are gradually being eliminated, chiefly by techniques, but in many cases by better selection of material, i.e., appropriate plasticization to suit the practical conditions to be met. Further advances are required to render non-migratory plasticizers more generally available and to establish specification standards for essential grades.

The p.v.c. covered wire has also been extensively employed, especially for single conductors in wiring chassis and panels, control equipments and domestic radio apparatus. Here, again, recognized standards are sought—and the more general acceptance of non-migratory plasticizers. For longer-term equipments, the p.v.c. covered, textile lapped and lacquered type of material seems to be more suitable, and is already giving satisfactory performance in various parts of the world. It has been used in telecommunication equipments for such as the wiring of switchboards and exchange racks, but further experience in developing the best techniques for its use are required in this field before finality is reached.

A British standard is in preparation for the wide range of cables and flexible cords used for electric power and lighting up to 250 volts, the insulation on these comprising p.v.c. The radial thickness of the latter is greater (0.030 in. upwards) than that needed for telecommunication applications, which requires 0.008 to 0.012 in. for conductor sizes from 0.016 to 0.023 in., and allows plus and minus 2 and 3 mils tolerance over this range. This may account for the greater progress made in the power and lighting field, but an assurance of service for a much longer period in telecommunications is probably the main reason for cautious field trials before general adoption.

BASIC PRINCIPLES OF INJECTION MOULDING (*Continued from page 121*)

advantage of higher injection pressure and the resultant faster filling of the mould. With the ball check nozzle there can be no sealing line and the sealing point can be anywhere along the line given by the equation of state for the correct weight required to produce a good moulding.

In Fig. 6 the mould is filled at some pressure and temperature determined by the injection pressure and heater controls. During the plunger forward time there is packing into the mould, as in conventional moulding (AB). But as soon as the plunger returns the gate is sealed at a pressure and temperature higher than in conventional moulding but along the same cooling line that will give a good moulding. Since this packing period is much shorter than in conventional moulding the residual strains in the moulded piece are much less.

Conclusions

The plastic temperature and pressure in the mould are the main quantities that control the quality of the injection-moulded article. These two quantities are determined by some complex arrangement of the primary control variables listed in Table 1. Therefore it would be of value to the injection moulding machine operator to know and be able to control directly the pressure and temperature in the mould. Since this is not possible at present, the authors have tried to analyse the various controls and mechanisms available to determine how these controls are related to the pressure and temperature in the mould. It has also been shown how the quality of the moulded article is dependent upon the pressure and temperature in the mould. It is the belief of the authors that a more exact knowledge of what happens during the injection moulding cycle will aid the moulder in solving many of his problems.

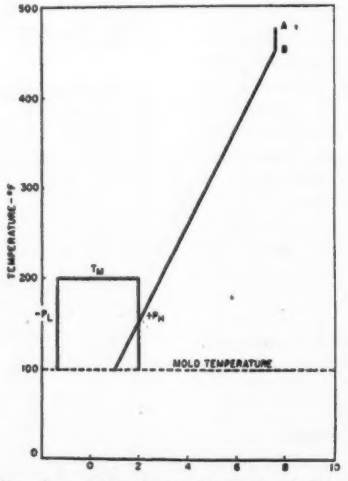


Fig. 6. — Pressure-temperature relations for the ball check nozzle.

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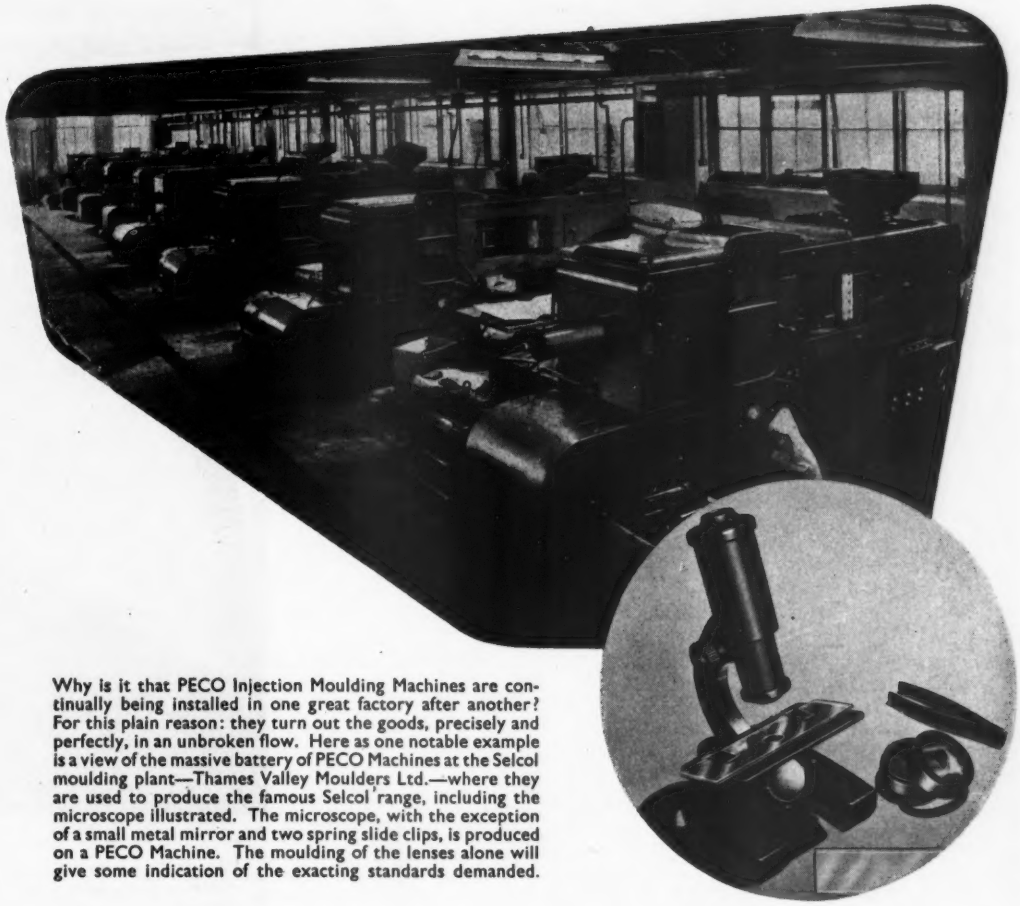
And Why is It Happening?



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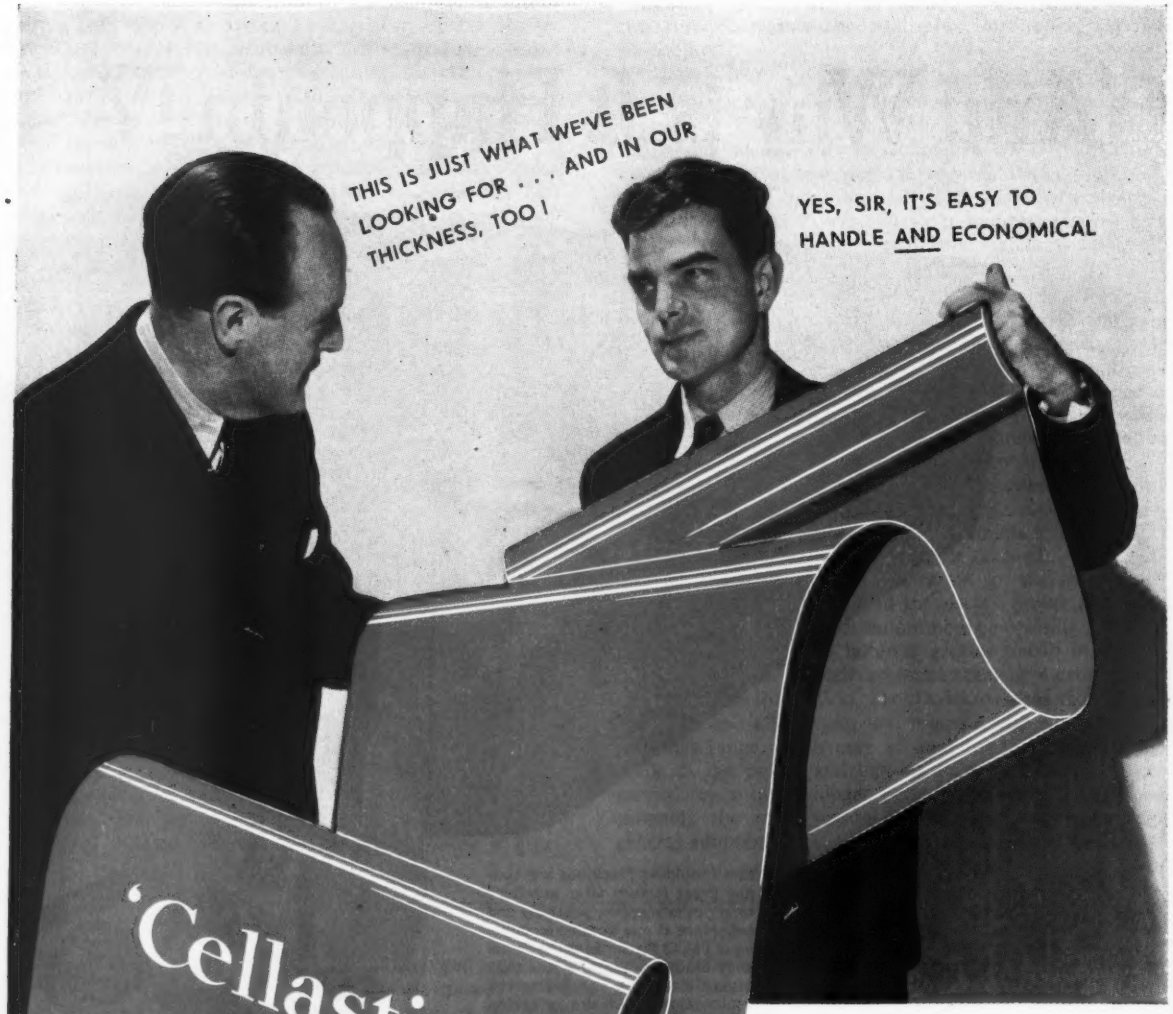

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PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. The country of origin for Convention Applications is shown in parentheses. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 2s. 8d. each (including postage).

B.P. 679,836. Preparation of polymers and copolymers of vinyl chloride. R. J. Wolf. To: B. F. Goodrich Co. (U.S.A.).

Monomeric vinyl chloride and its mixtures with copolymerizable monomers have been found polymerizable in the presence of aqueous solutions of acetic acid without the presence of emulsifying or dispersing agents. The dried polymers are very white and when mixed with plasticizers may be sheeted out or moulded into transparent films or plates of surprising clarity. With compounding ingredients, they may be extruded or moulded into electrical insulators of high resistance.

B.P. 679,837. Production of translucent material. J. E. Duddington, J. H. Davis, Imperial Chemical Industries, Ltd.

A solution of methyl methacrylate with up to 2% styrene (polymer or interpolymer with methyl methacrylate) is polymerized by heat between two parallel sheets of plate glass having a flexible gasket around their periphery. On removing the glass a sheet of translucent polymer is obtained.

B.P. 679,876. Sliding clasp fastener. Walter Grafton and Son, Ltd., G. W. Corsan.

The design is intended to facilitate the assembly of fasteners which may be moulded from synthetic resins (or diecast or stamped).

B.P. 679,941. Adhesive compositions. E. B. McMillan, A. R. Olson. To: B.B. Chemical Co., Ltd. (U.S.A.).

Very satisfactory thermoplastic adhesives are obtained by blending selected polymers of styrene, styrene homologues, substituted styrenes or mixtures. The compositions are particularly advantageous in shoe manufacture.

B.P. 680,010. Manufacturing cups, mugs and like vessels. S. C. Errington (Hanwell), Ltd., S. M. Weiss.

The body is moulded or pressed from an acrylic resin sheet with a protruding portion which is trimmed, locally heated and bent to form the handle.

B.P. 680,017. Dental prosthesis. G. S. A. Dahl, S. B. Almer. (Sweden).

The prosthesis has a facing of acrylic resin with at least one vertical groove bonded to a metallic backing with a lamella fitting into the groove. The binder contains an acrylic resin and a suitable solvent.

B.P. 680,054. Games practice balls. A. T. Hill.

B.P. 680,120. Motor vehicle wheels. F. W. Bluemel. To: Bluemel Bros., Ltd.

The side of the rim exposed to view is embellished by a plastic moulding (cellulose acetate).

B.P. 680,126. Method of and apparatus for forming and filling capsules from plastic materials. F. E. Stirn, A. S. Taylor. To: American Cyanamid Co. (U.S.A.).

A compacted charge is filled into a cavity formed in the plastic material and plastic material added. The filled capsules are sealed, permitting them to assume a stress-relieved shape. (Add to B.P. 674,172.)

B.P. 680,203. Plastic sheet material reinforced with fibres such as glass. To: S.A. des Manufactures des Glaces et Produits Chimiques de St. Gobain, Chauny and Cirey (France).

Individual glass fibres are wound as they are drawn spaced from one another in parallel arrangement on a rotary drum. Thermosetting or thermoplastic resinous material (e.g. phenol or urea aldehydes) is applied (by atomizer or vaporizer under pressure) uniformly to embed the fibres. Several layers may be combined.

B.P. 680,226. Paste-forming vinyl chloride polymer compositions. British Geon, Ltd., L. H. P. Weldon.

A certain content of powdered copolymer of vinyl chloride with vinylidene chloride and a complementary amount of vinyl chloride paste polymer will give pastes of reduced viscosity and lower gelling temperature while having good keeping qualities. The toughness of the gel is enhanced.

B.P. 680,239. Sticking together of sheets of cellulosic material impregnated with artificial resin of the thermosetting type. E. S. Hole.

The laminated sheet packs may be used as printing plates, matrices, or for other such purposes. Moist aluminium hydroxide forms the gelatinized constituent of the mixture with water applied to the surfaces of the resin impregnated sheets.

B.P. 680,245. Continuous process for producing novolaks. To: N.V. Philips' Gloeilampenfabrieken (Netherlands).

B.P. 680,330. Interpolymers of trichloroalkenes. T. A. Clayton. Comm. from: U.S. Rubber Co.

Polyolefinic esters can be obtained in an initially soluble, fusible state and may be "cured" after moulding or coating by an interpolymerization process with a trichloroalkene (obtainable from corresponding tetrachloroalkenes by dehydrochlorination with alkali). Further polymerization yields solvent and heat-resistant mouldings, coatings, films, laminates, etc.

B.P. 680,331. Mechanism for winding webs of flexible sheet material. Timsons, Ltd., E. A. Timson.

B.P. 680,339. Sanitary masks. B. Chapman. To: Chapman and Smith, Ltd.

B.P. 680,343. Manufacture of synthetic resins from aromatic substituted olefinic hydrocarbons. R. J. S. Jennings, A. F. Williams. To: C.D. Patents, Ltd.

B.P. 680,351. Bags or container liners of thermoplastic material and apparatus for their production. W. Hepworth, I.C.I., Ltd.

A direct heating electrical apparatus for sealing a flat endpiece to a tube is particularly applicable for making drum liners from polythene film (0.002 to 0.012 in. thick).

B.P. 680,359. Acrylonitrile copolymers and shaped articles comprising them. To: American Viscose Corp. (U.S.A.).

The acrylonitrile ternary copolymer contains at least 50% units derived from acrylonitrile, at least 5% of a certain vinylpyridine, and up to 15% units derived from styrene, vinyl acetate, or an ester of acrylic acid. The article is a synthetic fibre which can be dyed with an acid wool dye stuff.

B.P. 680,375. Bookbinding machine. I. Spinner, H. W. Dahly. To: Plastic Binding Corp.

B.P. 680,379. Die-casting machines, injection moulding or other like machines. H. Sauter, W. Hahn (Hahn and Kolb). (Germany).

The machine may be used for metal or thermoplastic materials. A pair of double-acting pistons, one connected to the injection head, the other to a movable die section, and in certain intercommunication are the characteristic parts of the hydraulic arrangement.

B.P. 680,380. Polymerization of vinyl alkyl ethers. To: Union Carbide and Carbon Corp. (U.S.A.)

The polymerization is carried out in the presence of aluminium hexahydrosulphate as catalyst.

B.P. 680,400. Ophthalmic lens for spectacles affording increased field of vision. E. B. Gatten.

B.P. 680,409. Light-stable compositions comprising polymeric vinylidene chloride or vinyl chloride. C. B. Havens. To: Dow Chemical Co.

A particular type of benzophenone derivative is used in the polymer composition.

B.P. 680,437. Laminated products. N. W. Knewstubb. To: Bakelite, Ltd.

For the stack of resin impregnated fibrous sheets, a surfacing layer is employed which is a fibrous sheet impregnated with a thermosetting synthetic resin which has been heated, so that it has lost its flowability while the resin in the core sheets is still flowable. The entire stack is subjected to heat and pressure. Suitable resins include urea, melamine or phenol-aldehydes. The products, which may be embossed, are hard and water resistant; paint or varnish adhere more tenaciously than to previously known laminates.

B.P. 680,441. Copolymerization of styrene and drying oils. British Resin Products, Ltd., S. E. Bradshaw, E. M. Evans.

B.P. 680,450. Seaming together of polythene film. W. Hepworth, I.C.I., Ltd.

Two seals with a short space between are much more than twice as strong as a single seal. The two parallel seals have a space between them of from 1 to 10 mm. width. Best results were obtained with narrow seals of 2 mm. width and a space from 3 to 8 mm. wide.

B.P. 680,455. Tooth brushes. F. Engel.

B.P. 680,461. Substituted aryl 6-tetrahydropyranyl ethers. To: NV de Bataafsche Petroleum Maatschappij (U.S.A.).

The compounds may be used as hardeners for protein containing films and as plasticizers for natural and synthetic resins.

B.P. 680,475. Process for the manufacture of artificial bristles, hairs, threads or the like. J. Boros (Austria).

Photographic film is used treated with a swelling agent at elevated temperature before being cut up.

B.P. 680,483. Method and apparatus for forming artificial teeth. To: Dentists' Supply Co. (U.S.A.).

A relatively transparent synthetic resin

(enamel tooth portion) is moulded over a preform moulding of a relatively opaque synthetic resin composition.

B.P. 680,514. Porous wrapper. To: American Viscose Corp. (U.S.A.).

The spaces between the yarns of a textile fabric are occupied by a hydrophobic synthetic resin.

B.P. 680,518. Measuring rules. O. Greene (U.S.A.).

A fabric cover and a series of stiffening ribs, which may be of thin spring steel or a suitable resilient plastic, are cemented together by a thermoplastic adhesive. The rule may be used in the manner of measuring tape.

B.P. 680,709. Production of moisture-proof sheet wrapping materials. W. Berry, C. R. Oswin, R. A. Rose. To: British Cellophane, Ltd.

Electrically charged colloidal particles of vinylidene chloride polymer (copolymer) are deposited on to a base sheet of good electrically conducting material having an electric charge of opposite sign. The deposited layer is then stripped from the base sheet.

B.P. 680,711. Production of heat-sealing, moisture-proof sheet of wrapping material. W. Berry, C. R. Oswin, R. A. Rose. To: British Cellophane, Ltd.

A highly moisture-proof base film of difficultly fusible vinylidene chloride polymer is coated with a certain more readily fusible copolymer.

B.P. 680,758. Anti-glare device for motor vehicles. H. E. Cato, J. L. Johns (Australia).

A tinted transparent sheet (plastics) has fine scratches on part of its surface dispersing the light while the position of the light source remains visible. The sheet may be attached on the inside of the windscreen. A downwardly projecting portion gives additional glare protection.

B.P. 680,785. Device determining the time from the stars. H. B. Milligan.

The discs (" sky dial " and scale carrier) are preferably made from transparent mouldable plastic.

B.P. 680,797. Sliding clasp fastener. M. Winterhalter. To: Soc. di Licenza Industriali SA.

Fastener members are die-cast (metal) or injection moulded (plastic material) in situ around an edge of a tape. The members have thin lateral extensions to improve the seating.

B.P. 680,800. Resinous compositions. G. Barnett. To: Bakelite, Ltd.

A proportion of a boric acid is incorporated in a phenol-formaldehyde resol.

B.P. 680,805. Apparatus for pressure moulding articles of plastic material, of edible material, and of non-ferrous metals. L. Deschamps (Belgium).

The apparatus is particularly suitable for moulding small articles of vinyl acetate and similar (thermoplastic) material. A hand-operated piston serves for drawing material from the main reservoir and forcing it through a system of pipes and a nozzle into the mould. The whole is immersed in a heated oil-bath.

B.P. 680,808. Collapsible tube with a spray outlet or the like. To: Cascelloid, Ltd. (U.S.A.).

Polyethylene may be used because of its resiliency.

B.P. 680,815. Atomizers. To: Cascelloid, Ltd.

Polyethylene may be used for the container and the stopper moulded from any thermosetting or thermoplastic material. Tubing inside the container may be of polystyrene.

B.P. 680,828. Moulding of plastic compositions. Dunlop Rubber Co., Ltd., G. H. Goulding.

The thermosetting or thermoplastic composition is shaped around a mandrel while supported at its end and between the ends. The intermediate supports are withdrawn while the composition is still in a plastic state, and then the setting of the tubular product effected.

B.P. 680,833. Manufacture of plastic articles, for example, gramophone records. J. A. Miller (U.S.A.).

The records are made from vinyl resins without plasticizers. Finely divided material is heated so that the particles frit together, forming a spongy mass approximately of the desired shape. This is transferred to a mould, where it is compressed under heat.

B.P. 680,890. Insulated bushings. To: Westinghouse Electric International Co. (U.S.A.).

The space between a stud and a porcelain sleeve is completely filled with a mica tape and a solid thermoset resin.

B.P. 680,896. Reeds for musical instruments. J. West, J. Brooksbank.

B.P. 680,908. Production of collars, cuffs and the like. H. Smith.

The article is cut from a sheet of thermoplastic material (plasticized polyvinyl chloride). The marginal portions are subjected to pressure and high-frequency heating.

B.P. 680,910. Toy building blocks. J. Thwaites.

B.P. 680,912. Cartons of the folding type. R. I. Long. To: British Cellophane, Ltd.

B.P. 680,938. Window shade material. To: E. I. Du Pont de Nemours and Co. (U.S.A.).

A flexible fabric base is coated with a halogenated ethylene polymer (main polymeric ingredient), pigment, plasticizer and magnesium oxide.

B.P. 680,942. Goggles. T. J. Rogers, J. A. Rogers.

B.P. 680,993. Method of maintaining adhesive pads for use with roofing felt or the like in a tacky condition over a long period, and adhesive pads produced by said method. S. A. Bevan.

" Cellophane " is used for the sealed envelope and for the outer wrapping.

B.P. 680,998. Process of coating paper. T. A. Clayton. Comm. from: United States Rubber Co.

The resinous polymers employed are selected from: polystyrene, polyethylene, polyvinyl chloride, polyvinyl alcohol and other vinyl copolymers, polymerized methyl methacrylate, copolymers containing styrene, acrylonitrile, etc.

B.P. 681,008. Laminated materials and webs for making such materials. J. Allan, E. B. Thomas. To: British Celanese, Ltd.

An excellent reinforcing fibrous material is woven from a high-tenacity, high-viscosity continuous-filament regenerated cellulose yarn.

B.P. 681,021. Matrix for production of plastic printing plates. H. M. Richardson. To: News Syndicate Co. Inc. (U.S.A.).

Frequent cracks and other causes prevented the use of plastic matrices for high speeds, pressures and numbers (newspaper). The difficulties have been overcome by utilizing a laminated blank with a compressible layer of cellulosic filler mixed with a heat-curing resin, a flexible cohesive layer coating of cellulosic fibres elastically bonded to one another and also impregnated with a heat-curing resin and a continuous film coating of a single-stage heat-curing resin. Blank and type form are heated and forced against each other at curing temperature.

B.P. 681,031. Cross-linkable and cross-linked vinyl copolymers. J. A. Bilton, G. H. Segall. To: Canadian Industries, Ltd. (Canada).

B.P. 681,070. Ice tray. R. S. Gaugler. To: General Motors Corp. (U.S.A.).

The grid of certain shape to facilitate separation of blocks is preferably moulded from polyethylene.

B.P. 681,093. Method and machine for moulding buttons and other small articles. W. W. Triggs. Comm. from: Maryland Plastics Inc.

Buttons are moulded under heavy pressure from urea or phenolic condensation products.

B.P. 681,097. Hypo-jet ampoule. S. G. Dehn. Comm. from: R. P. Scherer Corp.

The ampoule may be made from plastic material if greater wall thickness is used to resist the high pressure generated.

B.P. 681,099. Method of producing a resinous composition containing glycidyl ethers and suitable for use as an adhesive, the resinous composition so produced and articles made therefrom. To: NV de Bataafsche. Petroleum Maatchappij (U.S.A.).

The composition is useful as metal-to-metal bond, resin-to-metal, metal-to-wood, wood-to-wood, metal-to-rubber. See also B.P. 680,997, 681,001, 681,108.

B.P. 681,117. Sliding clasp fasteners. E. Sander (Germany).

The fastener consists of a resilient under-engaging and over-engaging strip and may be made, e.g., of polyvinyl chloride (" Igelit ").

B.P. 681,120. Preparation of copolymers of vinylidene cyanide. To: B. F. Goodrich Co. (U.S.A.).

The material may be melt spun and may be cast into excellent films.

B.P. 681,121. Making gas-expanded organic plastics. To: United States Rubber Co. (U.S.A.).

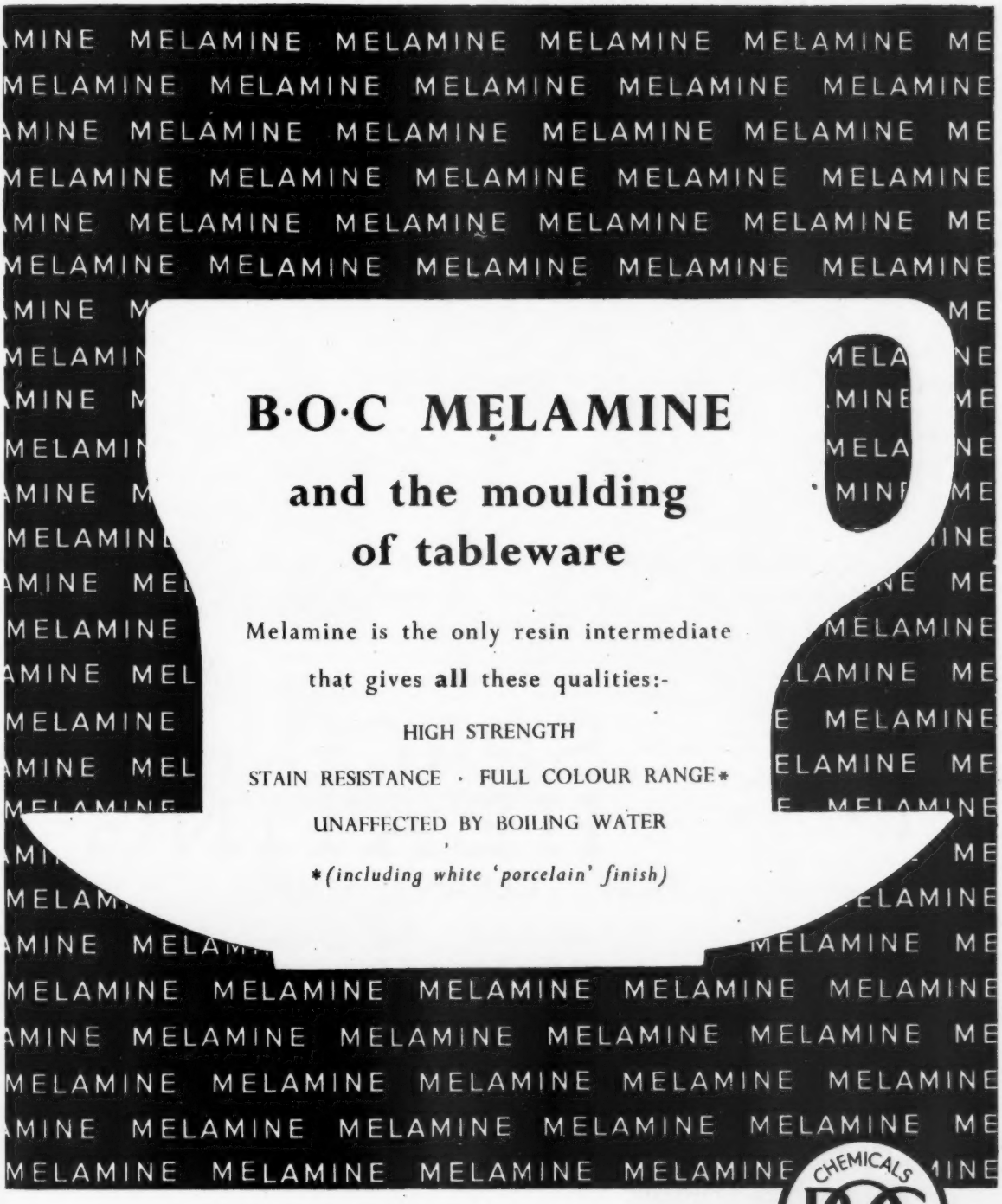
For chemically blown plastics (or cellular rubber), hydrazine (NH_2-NH_2) is an unusually effective blowing agent.

B.P. 681,125. Honing elements. To: Micromatic Hone Corp. (U.S.A.).

The backing member is made of a mouldable material (thermosetting plastic), so that the entire element can be moulded together in one simple operation.

B.P. 681,266. Manufacture of resinous condensation products and of leather. T. White, J. R. B. Hastings. To: Forestal Land, Timber and Railways Co. Ltd.

Condensation products from aliphatic aldehydes and ketones can be made water-soluble by the introduction of sulphonic acid groups. They have a high tanning content.



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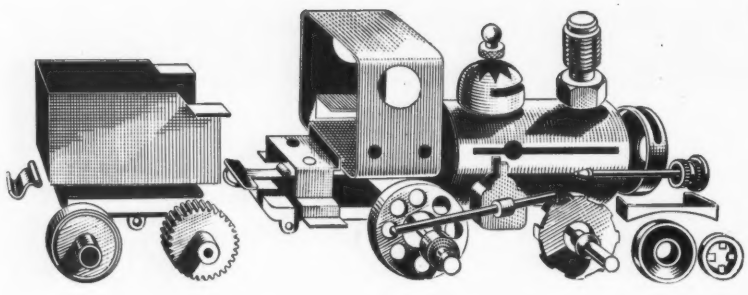

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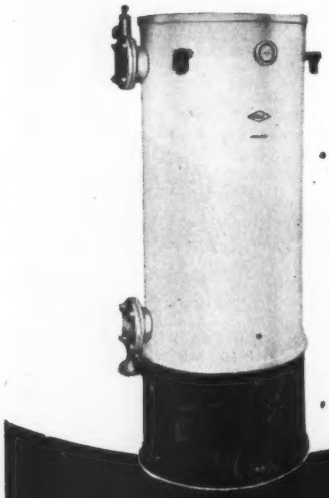

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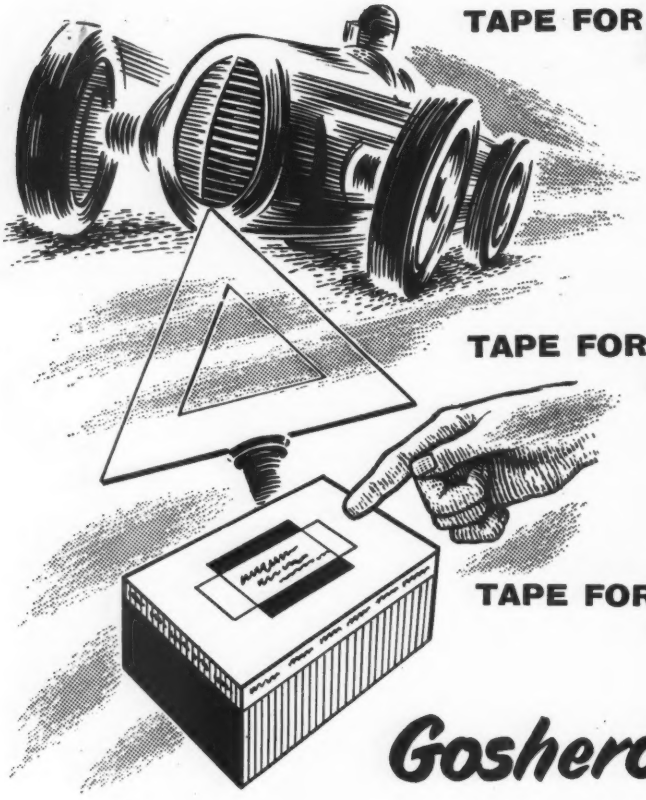

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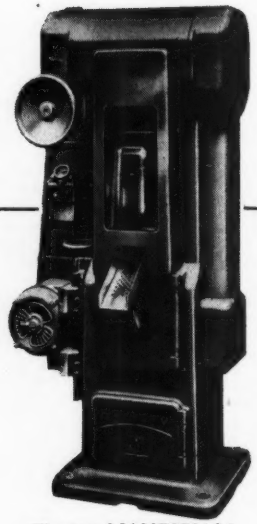

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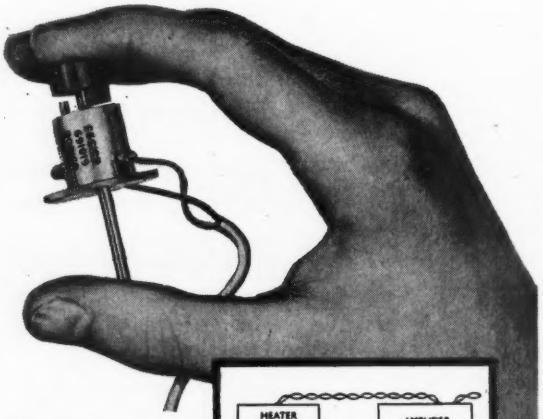
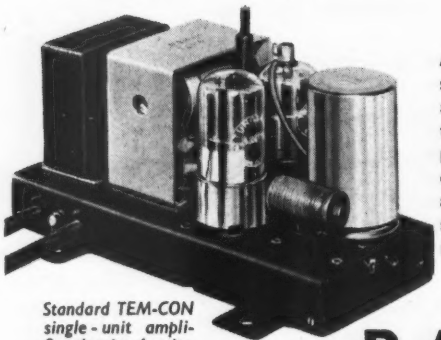


The TEM-CON Electronic System



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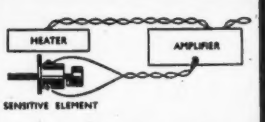

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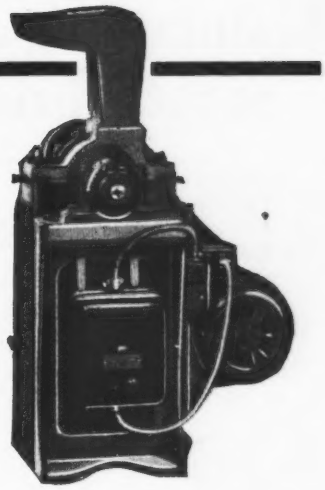

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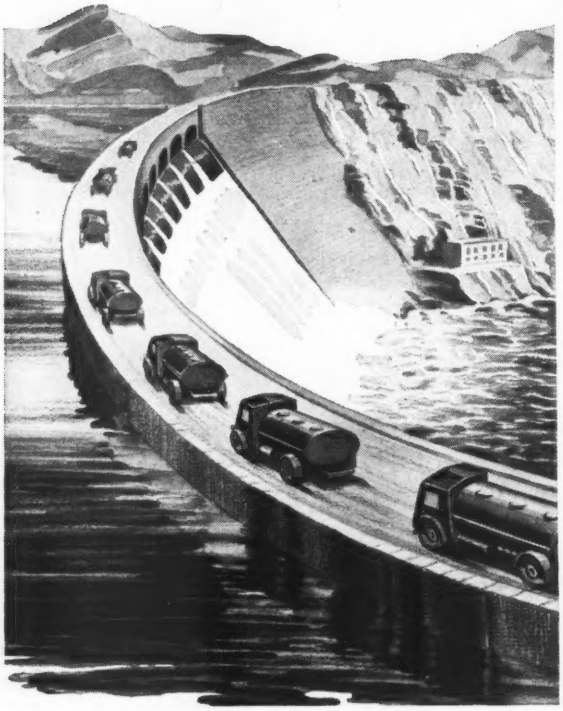

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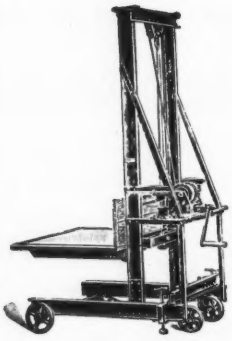

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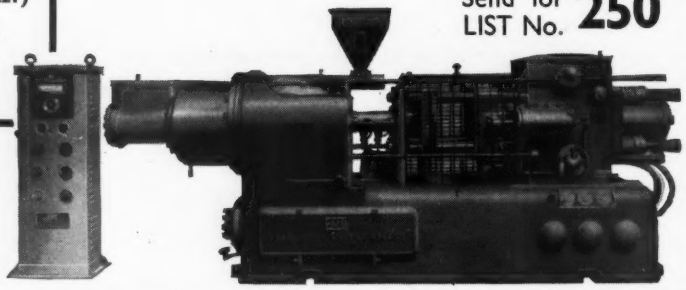

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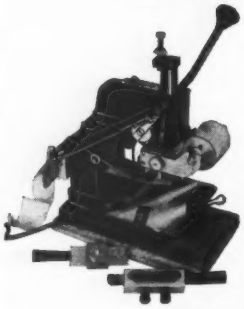

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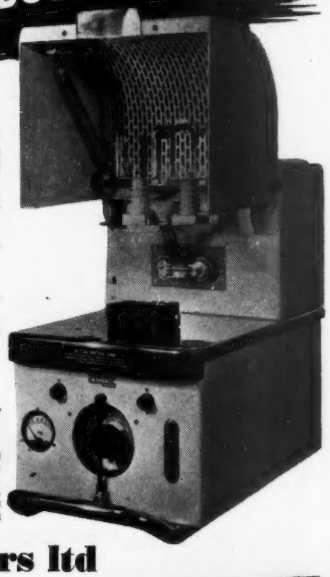

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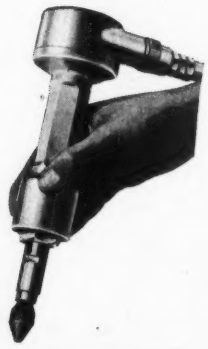

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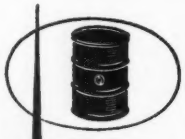

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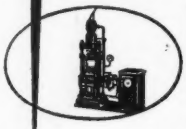

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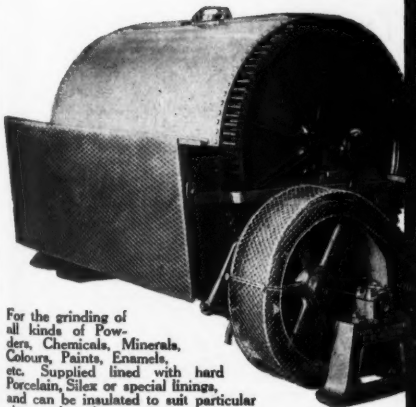

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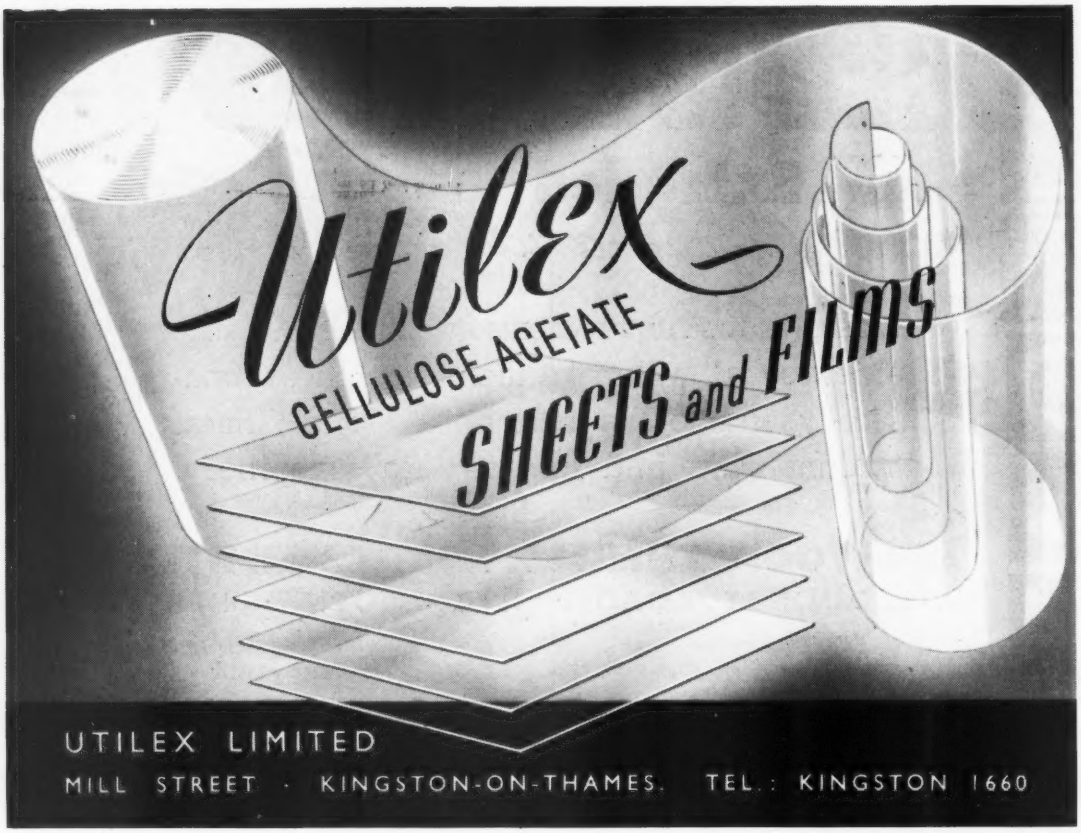

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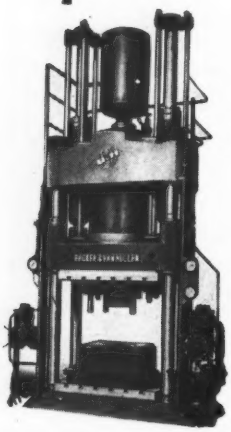

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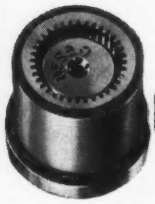

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CHEMIST required to work on aircraft plastic development, some experience desirable, B.Sc. or A.R.I.C. essential, preference given to applicant with metallurgical experience. Apply, stating age, qualifications, experience and salary required, to the Personnel Officer (Department P/C.1), Saunders-Roe, Ltd., East Cowes, Isle of Wight. 189-24

P.V.C. PLASTICS TECHNOLOGISTS, able to control production, required for Spread P.V.C. on fabric development. State qualifications, experience, particulars of previous employment, class of work used to and wage required. Box P891, care of "Plastics." 189-25

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DEMONSTRATOR required for injection moulding machines, young man with good practical and technical background, including knowledge of hydraulics and plastics machines preferred, good salary and splendid opportunity for advancement. London headquarters. Write in confidence, giving fullest details of experience. Box P898, care of "Plastics." 189-40

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CELLULOSE ACETATE PLASTICS, by Vivian Stannett. A complete technical survey of one of the most popular and adaptable products of the plastics industry. "Excellently illustrated, thoroughly up to date."—Chemical Trade Journal. Illustrated, 284 pages, 30s. net from booksellers, or 30s. 8d. by post from the publishers, Temple Press Ltd., Bowling Green Lane, London, E.C.1. zzz

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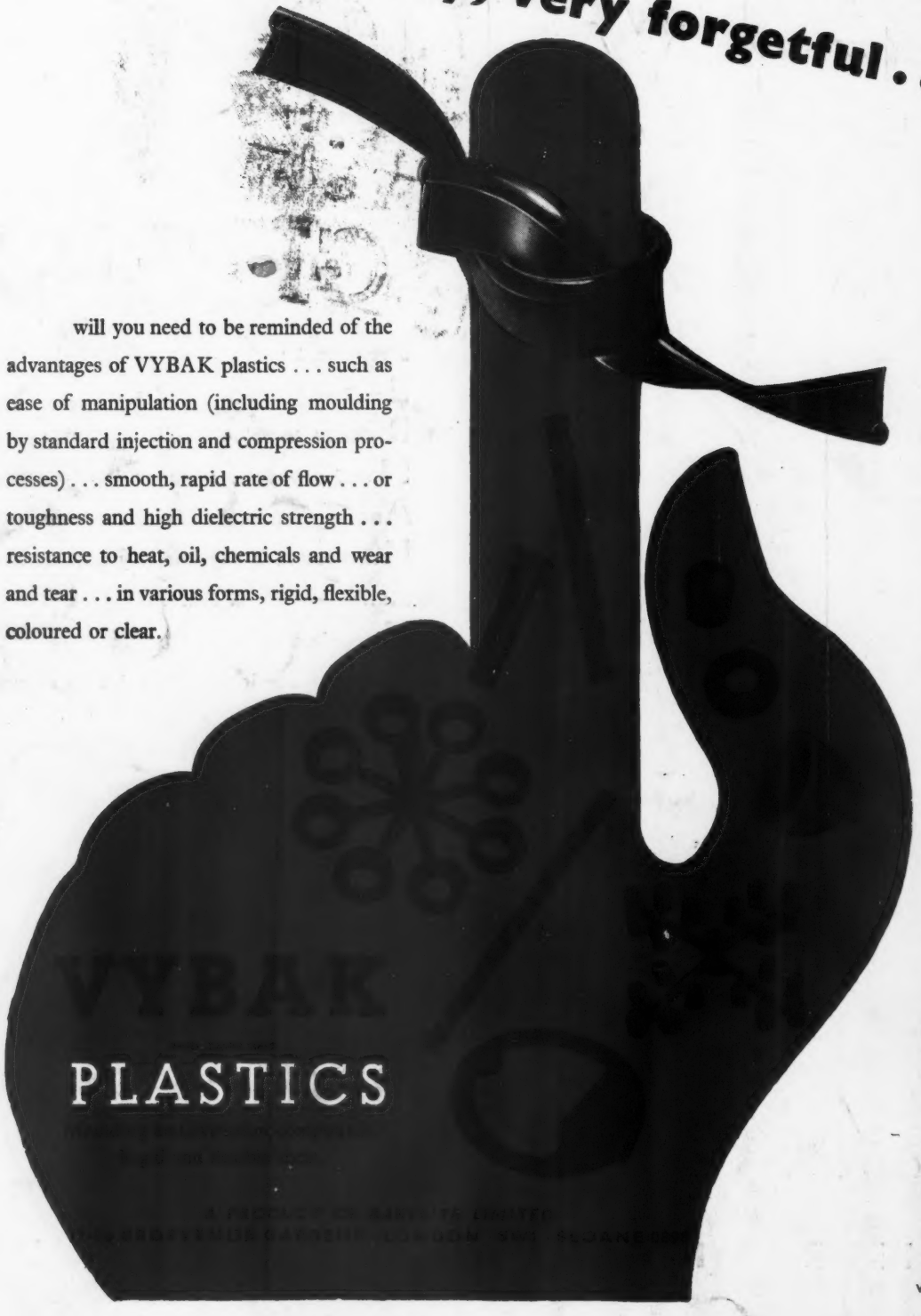

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